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# RUSSIA'S SYSTEM OF INTERNAL WATERWAYS.

*By Alexander Hume Ford.*

WITH EDITORIAL INTRODUCTION.

A PARALLEL has been suggested, not inaptly, between the development Russia is undergoing to-day and that which marked the industrial history of the United States during the past century. Unlike as are their political systems, the economic positions of the two lands present a good many features in common—each a region of vast territorial extent, singularly rich in fertile soils and mineral deposits, changing rapidly from purely agricultural to largely industrial occupations under the influence of ideas and agencies coming from without.

Russia's political condition has kept her in isolation almost as great as that which geographical conditions imposed upon the United States. In her new awakening, and in the exploiting of her natural resources, like the new world she has opened avenues for the capital, energy, and engineering skill of countries farther advanced industrially. The movement has been more rapid—more dramatic—because highly developed machinery and fully tested methods stood at her very doors, ready for instant application, while the exploitation of the American continent in a great measure proceeded *pari passu* with the evolution of the machinery of transport and of industrial production.

In this material upbuilding, the first process is the development of

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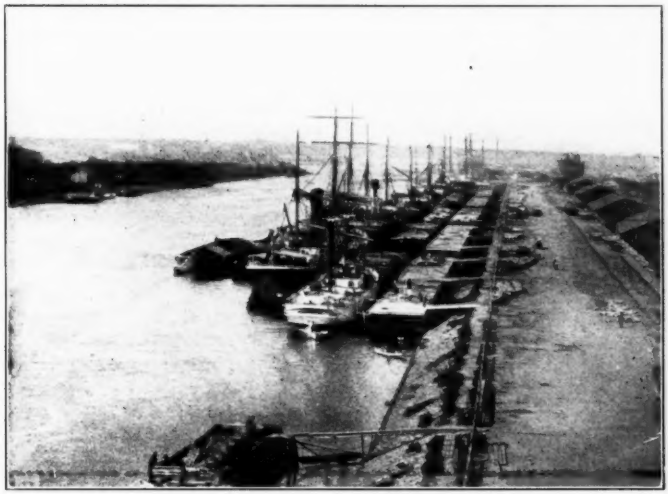
transportation. It was the great natural waterways of the central States that opened the country to the sweeping flood of civilisation. The Ohio and Mississippi in America—the Volga, the Don, the Dneiper, the Kama in Russia—serve to the interior of those vast tracts as the sea served to England or to ancient Greece, that is, to make a plain road for traffic and exchange with distant markets. Water transport, bringing in heavy machinery and supplies, bearing out great bulk of products, moving population and materials smoothly and cheaply from point to point—this is the great fostering agency in the early stages of the making of an industrial and commercial empire. Later comes the railway, meeting conditions attending the progress of settlement and development of the country, to which water transport is no longer adequate. But the river and the canal are pioneers, path-finders, promoters, and faithful coadjutors of the railway. It is to the internal waterways of Russia, therefore—to the natural advantages with which the country is remarkably endowed and to their well-devised improvement and extension—that the first of Mr. Ford's articles on Russian industrial conditions and opportunities is devoted.—THE EDITORS.

THE canal system connecting the waterways of Russia with each other and with those of Europe may be said to have had its inception at the little town of Zaandam, in Holland, where Peter the Great served his apprenticeship as a ship-builder and incidentally became impressed with the value of inland waterways.

In his early youth this indefatigable worker began laying plans for the commercial development of his domains. Before he became Tzar he had organized a Board of Water Communications in Russia, of which he was the first chief. When he had founded the city which bears his name, the Great Tzar turned, with his own hand, the first spadeful of earth from the canal which was to bring the capital on the banks of the Neva into communication by water with the most distant parts of his empire, the Arctic Ocean to the north, the Caspian to the south, and the borders of Asia to the east, while westward lay all Europe, with its system of inland waterways then in process of development.

For more than one hundred years after the commencement of Peter the Great's life work the waterways were the only practical means of cheaply transporting the products of Russian soil and industry from one part of the vast domain to another. No other

country is so prodigally endowed with navigable rivers. In European Russia alone fully 60,000 miles of inland waterway were navigable to the simple barges of those days. The rivers of Russia have their sources within a comparatively few miles of each other, all of the great streams rising within the area of the broad plateau of the north, so that it was no difficult feat to connect the headwaters of the numerous rivers. The construction of less than 4,000 miles of canals and canalized rivers, of less than 900 miles of actual canal, made it possible to



WHARF ON ALEXANDER III. CANAL, ST. PETERSBURG, WITH SEA-GOING SHIPPING.

travel by barge from Archangel, on the Arctic, to Astrakan on the Caspian, a distance of more than 3,000 miles, from St. Petersburg to the foot of the Urals, and from the Baltic to the Black sea by three distinct routes, to say nothing of Moscow and numerous other inland cities which were brought into direct water communication with all parts of the empire.

The consolidation of Russia was brought about chiefly by means of its waterways. Before the Christian era Greek fleets ascended the streams flowing into the Black Sea from northern Muscovy. Later the Slavonic armies floated down those rivers on rafts and barges to expel the Golden Horde. Almost in our own times the Turks have been expelled from the deltas of Russia's southern rivers, while in the last two centuries bands of armed adventurers, by following the natural waterways across Siberia, have carried the banners of the

ST. PETERSBURG FROM ACROSS THE NEVA.

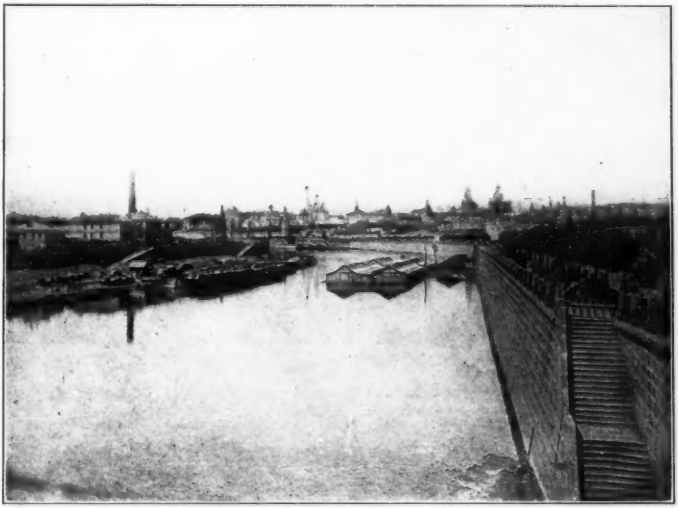
Tzar beyond Lake Baikal, completing in our own day the conquest of Siberia by means of flotillas on the Amur, to say nothing of events even now taking place on the Sungari River, in Manchuria, which is being used as a military base, along which munitions of war and railway material can be quickly conveyed from place to place.

For a century the network of waterways in European Russia amply served the needs of the peasants who cultivated the farms on the river banks, but with the coming of the railway a new order of commercial life sprang into existence. Russia began to merge from the primitive, her population increased by leaps and bounds, until it now exceeds 100,000,000. Cities sprang up along the lines of rail and for more than fifty years the improvement of waterways was all but neglected. The railroad alone was to be the means of regenerating commercial Russia, but with the advent of Prince Hilkoff, fresh from his apprenticeship in America, as chief of the rail and water systems of Russia, a change was announced. It has been decided that the railroads of Russia are to be auxiliary to a more perfect system of inland communication, which is to be the feature of the twentieth century. Old canals are to be rebuilt on a larger scale, and colossal projects are being considered for perfecting the inland system of waterways so that they may be used in connection with the railroads, each acting as a feeder of traffic to the other.

The greatest project at present under discussion in Russia is the

Baltic-Black Sea ship canal. The plan was first suggested by a syndicate of Belgian and French engineers who wished to build and control the canal, but the government would listen to no project granting a private concession. The syndicate then offered, for the sum of $700,000,000 to cut a 28-foot channel from the Baltic to Kherson, on the Dneiper, giving a waterway from sea to sea, a distance of nearly 2,000 miles, deep enough to float the heaviest battle-ships in the Russian navy.

This wonderful canal, which, when built, will put all of earth's other engineering achievements in the shade, is but a beginning of Russia's projects for perfecting an inland water system evidently destined to make her the greatest commercial nation of the world, if carried to completion. The narrow peninsula connecting the Crimea with Russia is to be cut through, thus bringing Odessa and the sea of Azov hundreds of miles nearer each other. Already Sevastopol is declared a closed port and its merchants and shipping have deserted it for other cities. From the Sea of Azov a ship canal is to be dug to the Caspian Sea, thus bringing central Asia in direct steamship communication with America and the rest of the world. It is in southern Russia and Trans-Caspia that American commerce is increasing so rapidly as to give cause for serious alarm to the manu-



THE BEGINNING OF THE CANAL CONNECTING MOSCOW WITH THE NATURAL WATERWAYS.

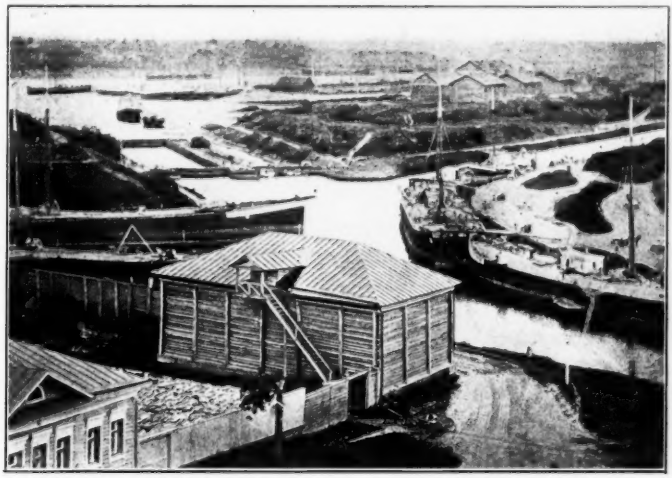
facturers of Germany and England. Russian engineers who have closely watched every new invention made necessary to overcome difficulties encountered in the progress of the Chicago Drainage Canal express a belief that the cutting of a canal to unite the Black and Caspian Seas, with the use of American machinery, will not be an impossible task. A company has recently offered to complete the

LOCK ON THE SAIMA CANAL, FINLAND.

work for the sum of $40,000,000. In fact, numerous preliminary surveys have been made of suggested routes; nor was Peter the Great responsible for the first suggestion of a connection between the two seas. As far back as 1568 the Turkish Sultan Selim, desiring to get his fleet upon the Caspian Sea, where it could attack Persia, attempted to unite the waters of the Don and Volga at a point where they approach within a few miles of each other. The work was abandoned, however, to be taken up by the energetic Peter in 1701 and pushed vigorously, but for once the great monarch was baffled by the waters and he, too, reluctantly abandoned the project. The chief difficulty in the way of building a ship canal to connect the two seas is the shallowness of the river Don, for although steamers ascend its waters for a thousand miles to bring down the coal from the mines that open on its very banks, they have trouble at certain seasons in keeping off the sand bars even at the mouth of the river.

About the delta of the Volga the shores of the Caspian are low and swampy. Following one proposed route between the two bodies of water, the surface of the country rises to not more than 118 feet above the level of the Caspian, and but 33 feet above the Black Sea, so that a canal once cut would need locks only to prevent a too rapid flow of water, while a constant flow from the inexhaustible supply of the Mediterranean might in time cause an appreciable change in the level of the Caspian, extending its borders toward ancient limits and making the proposed plans for uniting it with the Sea of Aral more easy of accomplishment.

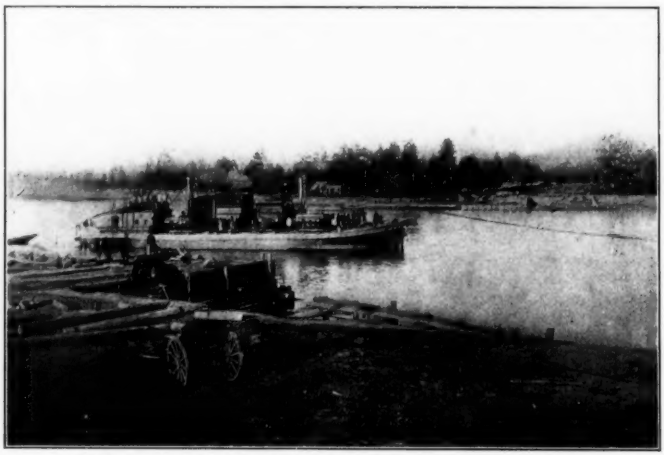
The construction of a canal connecting the Don and Volga rivers would complete an all-water route around European Russia just within its borders. The scores of steamers that ply between Archangel and St. Petersburg, continuing thence to Astrakan as they sometimes do even now, might return via the Dneiper route. Every year the depth and usefulness of the canals and waterways of Russia



THE MEETING OF FOUR CANALS, AT RYBINSK, ON THE VOLGA.

is increased; in 1842 the barges entering St. Petersburg through the waterways from the Arctic Ocean and the Caspian Sea were of no greater capacity than 160 tons; now craft carrying 1,000 tons and over easily pass through the locks, and with enlargements soon to be made even this capacity will be greatly increased. Everywhere up the Volga and its hundred tributaries ascend the iron barges of the Caspian Sea oil fleet, while through the canals to St. Petersburg

alone pass annually, during the 215 days of free navigation, thousands of steamers and barges bearing millions of tons of freight. Every known means of locomotion is used, from men, who, like oxen, tramp the two paths, hauling the smaller barges, to powerful tugs that creep along by means of a heavy chain laid in the beds of the canals and minor rivers, dragging after them at snail pace great caravans of heavy barges. From the greater streams immense craft nearly 400 feet long, 15 feet in depth, carrying 6,000 tons of freight, drift down to the Caspian, where they are broken to pieces to be used as firewood on the steamers going up stream. In all there are 8,000 miles



BARGE BEING HAULED UP A RUSSIAN RIVER BY A HEAVY ROPE.

The rope or chain is laid in the river bed and is picked up by the steamer, passed over a revolving winding drum, and dropped astern, thus giving a slow haulage. The same system is in use on the Rhine and other European rivers.

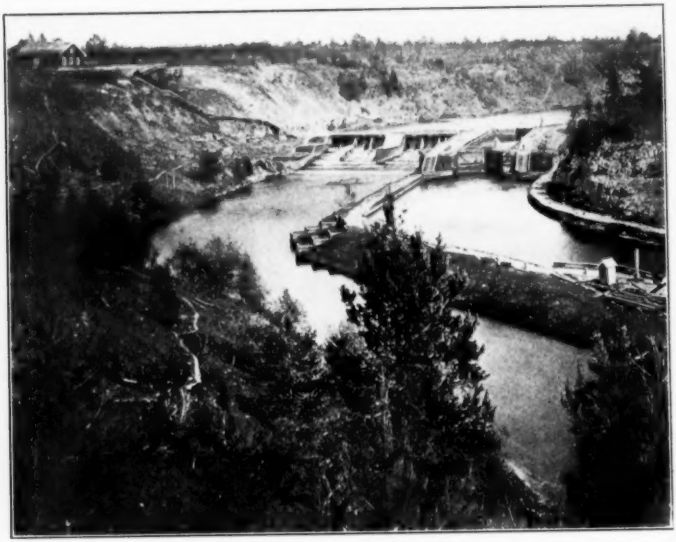
of navigable waterways in the valley of the Volga, or, if the streams which float the giant rafts that form so large a part of the traffic of the rivers are included, the mileage is increased to nearly 15,000, or as much as that of the valley of the Mississippi. Fifty thousand rafts are floated down the Volga annually, many of them 100 feet long by 7 thick, and this gives but a faint idea of the real traffic of the river: for in addition there are ten million tons of produce passing up and down the river during the open season. Much of this centres at Nijni Novgorod. To this famous market steamers and barges come from all parts of Russia, bringing goods to be sold at the great annual fair, over $200,000,000 worth of merchandise changing hands in a

BARGES AT NIJNI-NOVGOROD.

The immense total of merchandise dealt in at the annual fair is transported largely by water.

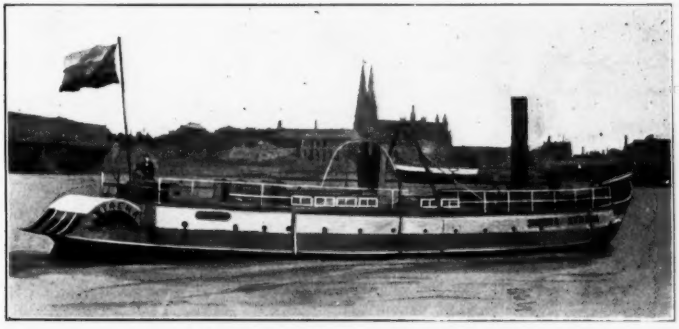
CRAFT LAID UP FOR THE WINTER ON THE VOLGA.

ON THE MARIE CANAL BETWEEN ST. PETERSBURG AND THE VOLGA.



ABANDONED LOCKS ON A CANALIZED RIVER.

few weeks; 30,000 craft, including rafts, are required for this traffic; they come from as far north as Archangel, as far east as the Urals, from Astrakan in the south, St. Petersburg and Moscow to the west; while great caravans of ships of the desert arrive daily from all parts of Asia. Yankee methods are revolutionizing traffic on the Volga. American steamers modeled after the Mississippi floating palaces now ply every part of the river, cutting through the water at the rate of 20 miles an hour and burning petroleum refuse in place of coal. More than a thousand of these passenger and freight steamers are now in use on the Volga, some of them having been in commission since 1872. On the lower river great dredges, designed in Chicago and built on the model of the American Government boat Beta, the crack dredger of the Mississippi, are deepening the channel to the

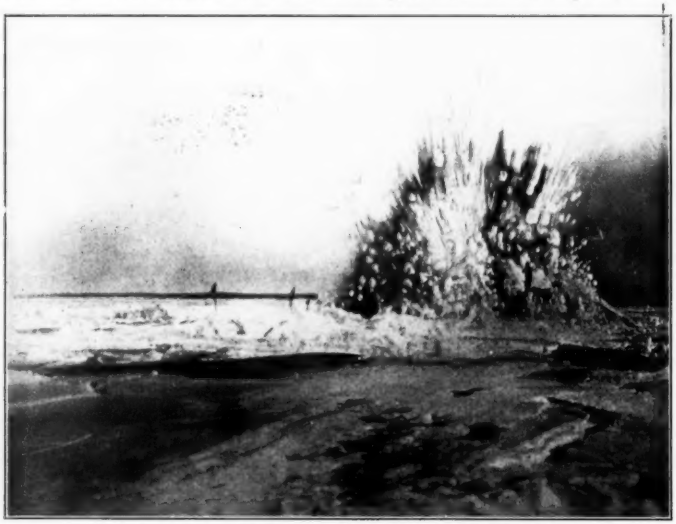


A VOLGA RIVER STEAMER. STERN-WHEEL TYPE.

Caspian. These mammoth machines, with their great rotary suction pipes, have already proved so successful on the Volga that the Russian Government has decided to use them in other parts of the Empire and to maintain a much greater depth in the rivers than ever before contemplated. One of these dredges, built by the John Cockerill Company, of Seraing, Belgium, is now at work pumping a channel through the upper Caspian, where the waters are extremely shallow after certain winds. The railroad is being pushed to Astrakan, and with the completion of the new channel, the largest vessels of the oil fleet will unload at the railroad wharf instead of transferring cargo to light-draught vessels several miles out at sea.

Russia has projected greater things in Central Asia than in any other part of the Empire; not only are thousands of square miles of desert being reclaimed by irrigation and thus made the most productive land in the world, but the mighty Oxus is to be diverted from

its present bed to its ancient and deserted course, so that it will once more flow into the Caspian Sea. This river rises in India beyond the Pamirs, flowing for more than 1,500 miles to the Sea of Aral; its volume is three times as great as that of the Danube, and for the greater part of its length it is possible for large steamboats to navigate this famous river. Even at Charjui, where the Trans-Caspian Railway crosses it, the Oxus is as wide as the Mississippi at Memphis, and from this point to the borders of Afghanistan a regular line of Russian steamboats is maintained to carry passengers and freight back and forth. The Russian engineers have located the old bed of the Oxus and anticipate no difficulty in altering the present course of the stream, but as it is estimated that 25 years would elapse before the first drop of water would find its way across the thirsty desert of the Caspian, it is quite possible that advantage may be taken of the fact that the Sea of Aral is 200 feet higher than the Caspian, and a



BLOWING UP THE ICE TO OPEN NAVIGATION AT RIGA.

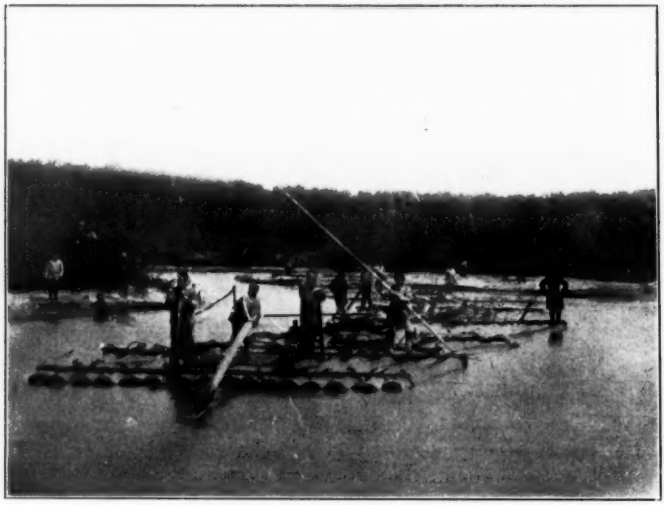
channel dug through the old bed of the gulf which once connected the two seas. And it may yet be made possible to travel by barge half way around the world, for Russia will not permit her plans in Siberia to be thwarted by the Urals, as her designs on India have been by the Pamirs. From St. Petersburg to Tcherdin, at the foot of the Urals, she sends her steamboats. From this point a canal will

some day find its way between the low hills to the level plains of Asia, scarce a hundred miles further on. In fact, a few years ago the mine owners in the Urals began the construction of such a canal, which would have given a direct navigable waterway from the Baltic to beyond Lake Baikal, but after a few miles of the canal had been built the Government ordered the work stopped, on the ground that it was

BANK-PROTECTION WORK ON A RUSSIAN RIVER.
Making and setting brush mats.

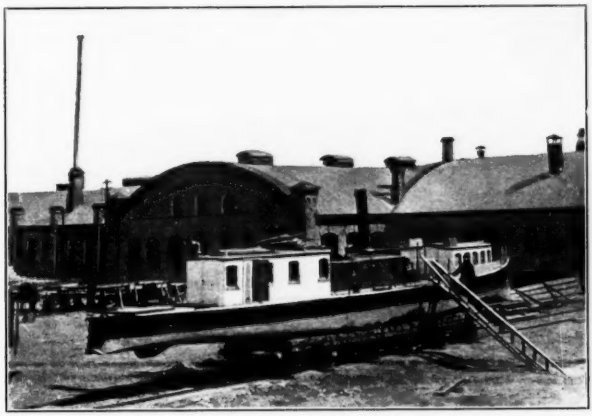
of too great importance to be undertaken as a private enterprise. The Government expects soon to make the necessary appropriation to complete this most important piece of engineering. For many years the available routes have been sought by the Government by which the rivers of Russia and Siberia could be connected. Already the Dwina is made tributary to the Kama, and it is hoped that in time the Petchora will also be united to this mighty stream, which, although but a branch of the Volga, is navigable for nearly 1,000 miles, and accommodates a traffic greater than that of the Mississippi. These northern rivers flowing into the Arctic Ocean are open to navigation but 100 days out of the year, yet they export half a million tons of produce annually, and so important is the port of Archangel considered that it is to be a terminus of the Trans-Siberian Railway, as well as of the great canal from Lake Baikal and beyond. For many years the Kama served as a part of the Trans-Siberian Railroad, and even previously convicts were sent by steamer and

PREPARING RAFTS OF LOGS ON THE UPPER KAMA.



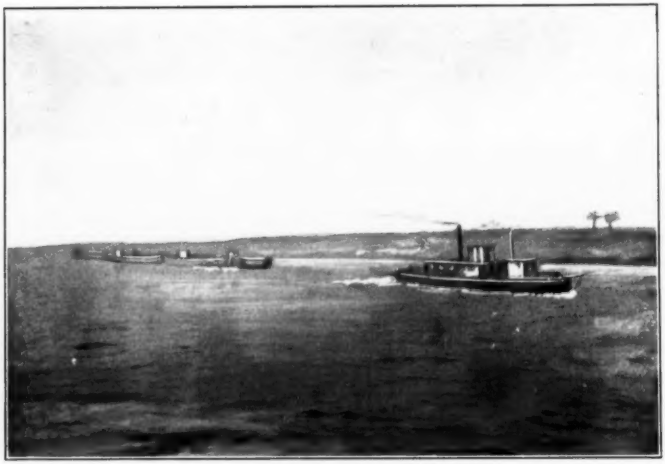
RAFTING LOGS ON THE KAMA.

barge to its headquarters in the Urals and then marched overland through the low valleys to the Tura River, where at Tiumen they embarked once more upon steamers for Tomsk. The Government long ago determined that a canal connecting the Obi and the Yenisei was indispensable to the development of Siberia, so an appropriation of 3,000,000 rubles was made and the work undertaken; upon its completion it was possible to travel by boat over 4,000 miles from a point in European Russia, near the Urals, to Kiakhta, on the border line of China. The vast low-lands of Siberia, constituting one-third the area of Asia, readily adapt themselves to the construction of waterways in almost any direction. Immense forests, greater in extent than any others in the world, supply inexhaustible quantities of



A STEAMBOAT BUILT IN SIBERIA FOR USE ON THE TRANS-SIBERIAN WATERWAY SYSTEM.

timber for locks. Great rivers flowing gently through the slightly sloping country are ready to float millions of valuable rafts to the ocean. Already English trading vessels steam from London to Yenisei, in the very heart of Siberia. With the completion of the Trans-Siberian Railway across Northern Asia, tapping each of its great waterways near the head of navigation, marvellous development has taken place in that vast but no longer unknown land. Where a few years ago the sound of a steamboat whistle was unheard, scores of vessels now ply the rivers of Siberia. At Tiumen are built steamboats that would do credit to any streams; from this point a regular line is maintained to Semipalatinsk, in Central Asia, near the Chinese border, a trip up the Irtish of nearly 2,000 miles. Another line is



A TOW ON THE OKA RIVER.

LOCK ON THE OBI-YENISEI CANAL, SIBERIA.

maintained between Tiumen and Tomsk, while barges arrive regularly from Krasnoiarsk, Yenisei, Irkutsk, and the Baikal district, all laden with produce and bound for the Urals, where the railway receives their freight. When the Trans-Ural canal is completed thousands of tons of grain, now left rotting at the Siberian railway stations for lack of adequate transportation facilities, will find their way into Europe via a cheap and continuous water highway. The splendid coal, iron, and gold mines abounding in Central Siberia will be developed to their utmost, and the waterways of Asia will become as important as those of Europe. That Russia realizes the value of her Asiatic rivers is evidenced by the fact that all tariff is removed from goods entering Siberia by water, and the trade America has built up with Amur River ports, Russia hopes to see extended to her rivers emptying into the Arctic Ocean.

The rapids between Irkutsk and Lake Baikal are being improved so that steamers may ply between the lake and western Siberian rivers, and it is needless to state that if such a thing is possible the waters of the Khila River, emptying into Lake Baikal, and the Shilka, flowing into the Amur, will be connected by a system of canals. Their headwaters are within a few miles of each other, in the valleys of the Yablonoi Mountains. Lake Baikal, 400 miles long and 60 wide, rests between a range of mountains, its surface being 1,230 feet above sea level, but the depth of the lake is nearly 6,000 feet; the Selenga, emptying into its southern side, is navigable for many miles through the valleys; of this river the Khila is a branch. At Chita, 300 miles from Lake Baikal, the Shilka River becomes navigable by steamboats of a light draft, to the Pacific, more than 2,000 miles distant. However, the Government steamers seldom proceed further up stream than Stretinsk, where the Trans-Siberian Railroad now ends; from this point to Khabarovka, where the railroad running north from Vladivostok terminates, hundreds of steamboats and steel barges run on regular schedule. At Khabarovka the Usuri River flows into the Amur, and steamboats ply up this stream to Chanka Lake, 100 miles from the navigable waters about Vladivostok; in fact, the upper waters of the Usuri almost reach the city. That a connection between the arm of the sea at Vladivostok and the Usuri would be worth many millions to the Russian Government is demonstrated by the fact that the mouth of the Amur is now seldom used. Ships unload at Vladivostok instead.

In conclusion a few statistics in regard to Russian waterways may not be out of place. Along the 60,000 miles of navigable waterways

in European Russia there are more than 1,000 ship-yards, which turn out annually 6,000 barges and 150 steamboats. In all there are 3,000 steamboats and over 20,000 barges plying these waters, employing fully 150,000 men. The total tonnage of Russian river craft has risen within the last fifteen years from 6,000,000 tons to about 10,000,000. Fully one-half the number of steamers and one-third of the barges belong to the Volga system. About 25,000,000,000 tons kilometer are moved during the six months of navigation, the freight per ton being one-fourth as much as by rail, so that during the season of navigation the railroads are compelled to lower their rates, notwithstanding which fact the waterways transport during the half-year almost as many tons of material as do the railways during the entire twelve months.

In Asiatic Russia there are 65,000 miles of navigable waterways, over 100 steamboats ply the Obi, 25 the Lena, and perhaps 200 the Amur and Sungari, while in Central Asia six or eight steamers move the products of the Amu Daria.

In the newly acquired province of Manchuria Russia's waterway luck does not desert her; it is possible to float every bit of material needed for the Manchurian railway up the Amur and Sungari rivers to a number of points of intersection of the Chinese Eastern Railway. At one time the Chinese Government contemplated the construction of a canal across Manchuria; should Russia carry out this design the waters of eastern Siberia and the wonderful canal system of China would be united.

In every direction Russia is still extending her frontiers by means of waterways or the iron rail, but it remains for the future to decide whether or not the stupendous engineering projects of Prince Hilkoff and his advisers can be carried to completion.

# INDUSTRIAL ASCENDANCY OF THE ANGLO-AMERICAN PEOPLES.

*By Casper L. Redfield.*

CONTEST is an instinct inherent in all living things. Plants and animals struggle with each other for existence, and the struggle determines which shall live and which shall die. With man within historical times this struggle has taken the form of war for robbery and for the political power of kings. With the advance of civilization and the accumulation of property, war has become so distinct a disadvantage that, at the present time, preparations for war are taken principally for the purpose of averting war. Though war is becoming day by day less likely, the instinct of contest remains and contest in the future will continue to exist between races as it has existed in the past between tribes and nations. Looking into the future by the light of the nineteenth century, it may be said that the coming struggle will not be one for political power, but a struggle for industrial and commercial supremacy. Industry and commerce, having become the source of all power among civilized people, now demand that form of security for life and property which can be had only through strong and stable governments. The expansion of strong and civilized governments over those less strong and less civilized is one, and practically the only present, mode of obtaining security for life and property. Even in those forms of expansion that savor of political aggression, it can be seen that the motive is not a conquest for rule, but a conquest for stable government and industrial prosperity alike for the conquering and the conquered. Among civilized nations, this is as true of the absolute monarchy as of the republic. At the present time no nation seeks control in China for any purpose except the advantages that its citizens might derive in the way of trade and commerce. Could all of the financial advantages to be obtained by opening up China for the introduction of modern improvements be settled in favor of one of the European

**It has been the steady preaching of this Magazine that, as engineering practice is the concrete expression of the material life of a nation, its elements will be found in the most deeply rooted institutions—racial, national, political, social. Mr. Redfield's analytical examination of the prospective trend of industrial power is strictly in accord with this conception. He goes direct to the primal elements of racial strength. An Anglo-American audience can hardly fail to be gratified at his conclusions.—THE EDITORS.**

nations, that nation would be only too glad to surrender the political power to anyone who wanted it. It is known, however, that political control in the hands of one nation would permit that nation to favor its citizens at the expense of those of other nations, hence it is evident that the political jealousies of Europe may be reduced to the fears of each nation that its rivals will gain control of the markets that it itself is seeking. We thus see that the only animus actuating the powers in China is an effort of each to secure for its citizens the profit naturally arising from exploiting the resources of the empire. To those who may think that running governments on sordid commercial bases is degrading, the reply is that the old idea that governments exist for the glory and power of their rulers is a thing of the past, and that in the light of modern civilization the only object of a government at all is to secure to citizens the right to accumulate property and enjoy the benefits of it.

In a struggle for commercial advantage and the wealth that goes with the control of markets, success is the goal for which all strive, be the contestants individuals, nations, or races. Success of any kind is the result of work, and to attain success there must be the men to work, the tools with which to work, and the materials upon which the work is to be performed. Given the men, the tools, and the materials, the measure of success will depend upon the quality of these elements, and also upon geographical position and political influence. It is the purpose of this article to take up these elements in detail, and, by examining them, to arrive at some reasonable estimate of the relative advantages of different peoples in the coming struggle for commercial supremacy.

Omitting the United States from the consideration, the most remarkable thing in modern history is the expansion and rise in power of the British Empire. As the area of the British Isles is almost insignificant, and as their population is less than that of several other countries, it is evident that their overwhelming wealth and power depend upon the expansion of the empire and the quality of the men who were able to expand it. So colossal is this world-wide empire, owned by the British people and controlled from London, that it has been likened to a pyramid standing on its apex and liable at any moment to topple over. As we shall presently see, it is a pyramid resting firmly on its base—a base composed of superior men, of superior intelligence and superior education.

Man is an animal, and Darwin has shown that not only is he closely akin to other animals, but that the laws which control the

development of the lower animals also control the development of man. He has also shown that crossed breeds of animals are larger and stronger than either parent. Thus, while the crossing of one breed of sheep with another may deteriorate the particular product for which sheep are ordinarily raised, the animals themselves will be larger, stronger, and healthier than either parent. Modern science has shown that with man a sound mind goes with a sound body, and that the larger and stronger the physical body the better are the chances for a large and powerful brain. And finally, common observation and experience teach us that the strong body and the powerful brain open up the wilderness, make our inventions, build our railroads and steamships, and control our manufactories and commerce.

When we examine into the origin of the English people we find the ancient Britons fighting and mingling with the Romans, and subsequently with the Picts, Scots, Danes, Saxons, and Normans. For more than a thousand years these various breeds of men have crossed and recrossed until they have been molded into that homogeneous mass that we know as Englishmen. From what has been said before we can see why the Englishmen are inherently of a sturdy stock, and why they have brains competent to grasp and manage the affairs of a world-wide empire.

Turning to the United States, we find the foundations of a new nation laid by the sturdiest and most enterprising of these same Englishmen. They landed on the then distant shore, conquered the wilderness, organized a new government closely akin to the old, and invited the people of all the world to join them. These strangers came and are still coming. Here they meet and here the same commingling that went on in England is going on, more rapidly and on a larger scale. The Slavs, the Germans, and the Latins mingle together and in a few years become neo-Anglo-Saxons, or what may be more properly termed Anglo-Americans. The evolution going on in the United States is also going on in Canada, in South Africa, in Australia, in New Zealand, and in other smaller places scattered around the world. There is thus being formed, on a gigantic scale, a new race of men, built on the strongest lines on which it is possible to construct human beings. The different sections of this new race have a common language and literature, the same laws and customs, and the trend of industrial civilization causes them to have identical political interests.

It is an established induction of science that plants and animals reach their greatest perfection near their northern limit. Applied to man we see the most powerful and dominant of the old races located

in the temperate zone. Going northward into the frigid zone or southward into the torrid zone we find men less sturdy and less intelligent. This potential difference between men in the temperate zone and those in the tropics is well illustrated by Mr. W. Alleyne Ireland, who has given many years to the study of British colonies. He says that "taking the British Empire as a whole, it is found that every man, woman, and child in the non-tropical portions sends to England each year $23.88 worth of produced material. Every man, woman, and child in the tropical portions sends to England each year 66 cents worth of produced material." This is a ratio of more than 36 to 1.

If we take a map of the world, or better yet, a globe, and trace the isothermal lines, we find the largest expanse of fine territory in the temperate climate in North America, and consisting of the United States and the southern half of Canada. The second in size lies in China; the third in central Europe; the fourth in Australia; the fifth in the southern extremity of South America; and the sixth in South Africa. This comprises practically all of the world that is suitable for the habitation of an active and energetic people. Of this territory more than one-half is in the undisputed possession of English-speaking Anglo-Americans. Of the other portions of the temperate zone, the only non-English speaking part yet open for considerable development is in South America, but the southern end of South America is the most isolated section of the world. In the frigid and semi-frigid portions Russia holds the largest section, while England holds the second in size. Within the tropics, England controls in India and Egypt the richest and most populous portions. It will thus be seen that, go where we will over the face of the earth, the English-speaking people have, in geographical position, an incomparable advantage over any other people.

If we look once more at the map and study it from a geological standpoint, we find that the greatest agricultural and mineral resources also lie within the sphere of Anglo-American influence. These are the materials upon which work is to be performed, and here again we find the advantages lying with the same people who had the congenital and geographical advantages.

Modern civilization rests upon modern engineering, and modern engineering depends upon modern education. In the past, education was supposed to be limited to the learned professions, by which were meant law, divinity, and medicine. To-day education occupies a wider field, and engineering is perhaps the most learned of all professions. While education has its foundation laid in schools and col-

leges, a comprehensive education consists of a broad knowledge of human affairs and events. This broad and most useful knowledge is gained by experience and from the current technical publications. It may thus happen that the best and most useful education may be possessed by men who never saw a college and very little of an ordinary school. That the English-speaking people have the best opportunities for acquiring the useful forms of education is shown by their technical publications, which exceed in number and circulation those of all other peoples put together. If technical publications were not used they would not be printed, and if they are used they educate. Experience is gained by contact with the world, and Anglo-Americans are noted for the extent of their travels and the amount of their communications with distant points. They make more use of railroads, steamships, and telegraphs than any other people. Another illustration of the comprehensive knowledge of English-speaking people is found in the language itself. The number of words indicates the number of ideas, and the number of words in the English language is three or four times that of any other language.

Education is one of the tools with which man works, and is that particular form of tool which enables him to handle other tools to best advantage. The other forms of tools are capital, lines for transportation and communication, commercial and manufacturing establishments, and the almost infinite forms of machinery in the invention, making, and using of which the Americans are the leaders. Of these various forms of tools not only are the Anglo-Americans as a class better supplied than is any other class, but they have more skill and experience in using them.

We thus see that there is a race of people of congenital superiority, the parts of which are linked together by ties of blood, of language, and of customs; that they are numerous and growing and are located in positions of geographical advantage; that the natural resources given into their possession are greater than those given to any other race; and that the tools and appliances which they have are better and more numerous than can be found anywhere else. If, with all these advantages, these people cannot win pre-eminent success, it will be because they have turned their backs upon progress to woo the goddess of degeneracy.

As to which branch of this race of people is likely to take the lead it is not the province of this article to deal, but it may be of interest to look at the immediate prospects before the people of the United States. Twenty years ago the country was just entering on an era of

prosperity after a serious and prolonged panic. To-day it is doing the same. With the men, tools, and materials at hand twenty years ago America built thousands of miles of railroads, founded and expanded cities, opened mines, erected manufactories, and put to use practically all the vacant land to be had. To-day she has fifty per cent. more men to do work; these men, especially in the engineering class, are better educated and trained and consequently are able to accomplish much more per individual; the available money capital is more than doubled; and machinery is several fold as plentiful and efficient as it was then. What is America to do with this tremendous potential energy? She cannot use it for building railroads in the same proportion as in the past, because she must have some ground left for agricultural purposes. She cannot use it in expanding her cities, because she could not fill them if she did. Doubtless some of this surplus energy will be used in added luxuries and in higher forms of education, but even then there will be a very large amount left over that cannot be employed advantageously within the United States. Fortunately there are in Spanish America, in the Philippines, and in China, fields for more improvements than can be furnished by the world in several decades. The greatest of these is in China, and the care of the United States there should be that no political settlement be made that will shut them out of a free and equal opportunity in that vast empire. If they should be shut out by discriminating spheres of influence, then a certain portion of American wealth-producing energy will go to waste, or else the United States will have to work at a disadvantage. In the Chinese field for development, the possession of the Philippine Islands gives the United States a distinct geographical advantage, and as they cannot benefit themselves without benefiting the people of those islands, it follows that territorial expansion not only means industrial expansion, but it means the bringing within the pale of civilization those who have been within the pale of barbarism.

# ORGANIZATION OF THE FACTORY SALES DEPARTMENT.

*By O. D. Hogue.*

WELL equipped, modern shops, ample capital, able superintendence, competent operatives, and a product of assumed or proven commercial possibilities—all these being given, there yet remains to organize an efficient system of sales, advertising, shipping, and accounting. The matters of advertising, shipping, and accounting are mentioned in connection with the sales department to emphasize the advantage of having them under the direct control of this department in all matters wherein the service rendered the customer or consignee is concerned.

The spur of self-interest is then sufficient to insure that the customers' preferences and directions as regards packing, shipping, and billing will be fully ascertained and intelligently acted upon. Or, if it is not possible to conform to his recommendations, the necessary letter of explanation is more likely to come fully and promptly from the department most keenly interested in retaining the customers' continued trade and preference, rather than from those departments more removed from actual contact with the customer and less appreciative of the vital importance of neglecting nothing whatever that will tend to retain customers and trade. Of the direct accountability of the advertising department to the head of the sales department there can be no question. The necessity for close and timely co-operation is immediately apparent as soon as the wheels of business are set in motion, and they do not need to be further mentioned herein as separate departments.

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The province of the mechanical engineer, *as* engineer, of course stops at the doors of the sales department. When he has completed the best possible construction at the lowest possible cost, he may well feel that his share in successful conduct of the works is completed. But the province of the industrial engineer extends over the commercial side of the enterprise also—from buying market to selling market—and he must be concerned with the machinery of trade and distribution as well as the machinery of production. It is with this conception of the position in which very many engineers are placed that the Magazine presents the accompanying brief practical review of the commercial aspects of mechanical manufacturing.—THE EDITORS.

In the case of business firms with closely allied connections, which can be depended upon to either buy or place the factory output, the question of sales is merely a matter of book-keeping; but in the vast majority of business dealings only the personal quality of attention and service distinguishes a concern from its competitors in both material and prices (understood, but never admitted), and the question of securing and retaining a normal share of current and profitable business is a vital one, and is generally given the attention that it merits.

These conditions indicate that the head of the sales department should be fairly competent to meet the requirements of the situation, as in no other position is any incompetency so noticeable and attended with such loss of old customers and failure to secure new business. Many examples illustrate the success of energetic, capable sellers in offsetting inefficiency of shop management and practice, until these shortcomings are slowly corrected in the growth and enlargement of the business fostered by the exercise of good judgment and efficiency in advertising and selling.

In starting a new business or reviving an established one, the necessity for getting promptly in touch with the greatest number of possible buyers is at once evident. As aids in this matter, there are the trade paper and the circular letter and a multitude of schemes of more or less merit, generally less as an average. The better class trade journal can be safely considered the back-bone of all inquiry-bringing schemes and efforts. The special circular letter, judiciously used, can be made to produce a very satisfactory number of inquiries, although, as a general rule, inquiries so stimulated do not yield as well in actual orders as the inquiries due to the regularly appearing, well-displayed advertisement. But the special circular letter in connection with matters of special interest, mailing new catalogues, new discounts, etc., is recommended, and will be found of much benefit in establishing regular correspondence with possible buyers. The combination of strong advertisements in the better class trade papers, with an occasional type-written signed circular letter, constitutes a force for publicity that will successfully introduce any commodity with merit, for which a rational use can be found by the trade in which the advertising medium circulates.

In the choice of advertising mediums there is much to be considered—circulation, standing, and appearance. Circulation is important, but *quality* of circulation is all-important. Better a moderate number of buying readers who value the publication sufficiently to pay

for it, than a multitude of mere names on a mailing list. A safe rule to follow in placing initial advertisements is to take moderate spaces in the best edited and most interesting of the trade journals circulating in the trade to be reached, and later modify the list as the resulting inquiries indicate and recommend. Again, it is absolutely necessary that the space purchased in the journals selected should be used to display matter that is attractive, pointed in phrasing, and calculated to make a favorable and lasting impression. Such an advertisement is possible, and no one now disputes that the advertising pages are examined as closely as any other.

A good advertisement can be prepared by anyone with the time and a thorough understanding of the matter to be made public. A clean, complete, direct statement, displayed in type of a size to be easily read, and enlivened with a good cut or white-on-black effect, is better than any arrangement savoring of the startling or the humorous. Very striking advertisements are possible by the use of unusual arrangement and design, but so many futile efforts are made in this direction that it is best to leave such attempts to the professional experts, subject, however, to the closest scrutiny by the sales manager before insertion in valuable space.

If the proper combination of time, talent and understanding is not available, money can be very well invested by placing the entire matter of preparing the advertisements in the hands of professional advertisement writers, of whom there are now several largely in evidence, whose work, moreover, as might be expected from those who intelligently cultivate a specialty, is of a superior order.

The appearance of the initial advertisement, if only passably good, is almost invariably followed by a most gratifying number of inquiries for catalogues and prices, followed later by an apparent industrial depression when the daily record of inquiries received is compared with earlier records. There is no occasion for alarm, however, and upon closer investigation the later inquiries will be found to grow more definite in their promise of business. If advertisements are keyed (and new advertisements should be keyed), a fairly accurate estimate of the business-bringing power of the different journals can be made and the list possibly rearranged with benefit when contracts are renewed. In this a distinction should be made between "inquiry producers" and "business producers." Herein the quality of the circulation is apparent, and an apparent lack of inquiries from a given source is often amply amended by the volume of business to be credited to it, owing to the publication being in the business-producing instead

of the inquiry-producing class. It is far from safe, however, to slight a seemingly idle inquiry, as close attention paid will develop many cases of bread cast upon the waters to return after many days. Further, it must be remembered that too minute attention to key indications may lead to serious error. A customer's inquiry cannot in every case be correctly traced to a particular publication. It may be taken for granted that constant appearance in a journal of assured value to, and large circulation among, a buying constituency, is certain to familiarize buyers with the name and merits of the article so advertised and to have a favorable effect on the general volume of business.

A complete record of all inquiries received and the total of the quotations made and business entered, when compared with the total cost of the sales department, permits of some interesting and at times startling comparisons. All of the comparisons will emphasize the urgent necessity for exhausting all order-bringing possibilities and giving to every detail pertaining to the securing of orders the closest continuous attention.

The cost per inquiry, when determined, will demonstrate that the additional expense of following up every definite inquiry until the order is secured, lost to the competitor, or the contemplated purchase abandoned by the prospective customer, is a good business proposition, and at no time a case of throwing good money after bad. All inquiries and communications should be promptly acknowledged as a matter of business form and courtesy. If further time is needed to reply fully to the writer, he should be so advised and definitely told when to expect a further and more complete reply. This is due to the party who offers a definite opportunity to secure business; he will appreciate it, and a good impression has been made even before the quotation reaches him.

In the United States, brief, pointed, and definite letters are preferred by the business interests. Such a letter need not be impertinent or unduly blunt. Outside of the United States a more elaborate and graceful form of correspondence obtains favor, but with a large business such forms add greatly to the stationery and labor account. The matter can be well decided by practice and individual tastes.

After the customer has been given quotations, a reply is due when he has been allowed two or three days in which to acknowledge and consider the offer made to him. The favorable reply will be promptly forthcoming in many cases. Others will need to be stimulated by what are known as "touch-up" letters. Such letters cannot be too ably dictated or too carefully considered. Their proper phrasing is an

art, largely a matter of particular talent in that direction, and of long practice. All inquiries not referred to travelers for full attention, should be completely threshed out by mail before recording for the annual catalogues and printed matter, and filed away permanently. A variety of office appliances are suitable for handling inquiries, the selection made depending on the volume of letters handled, bearing always in mind that the simplest appliance is the best.

In working over inquiries, the state of the deal governs the character and number of touch-up letters to be sent to obstinate cases. It is eminently right in these particular cases to bear in mind that having given an inquirer the attention he has requested, a definite reply is due in proper time, and that the later letters requesting it can have a moderate amount of that dignity due a position well-taken, entirely wtihout being impertinent or jeopardizing future business possibilities. The cases referred to are extreme exceptions. It is rare that any reputable business man fails to accord others that information that he would want were the positions reversed.

Throughout all correspondence and negotiations, it pays well to consider the customer as the very good friend of the firm with whom he trades. A strong feeling of mutual respect will grow out of a relation so handled, which will make it and subsequent dealings a pleasure as well as mutually satisfactory and profitable. This friendly feeling for the customer should permeate the entire organization, extending to every employee having to do with the execution of his orders, and all should unite in giving the best and most complete service to the customer who is helping to support them with his trade. It pays to do this, and it is right, and in connection with competitive prices, is the open secret of trade extension and consequent prosperity.

# ELECTRIC POWER MACHINERY IN IRON AND STEEL WORKS.

*By Sydney F. Walker.*

RON is found in nearly every part of the world, in combination with other substances, and the process of preparing it for the market as iron, or in the form of its alloys, cast iron and steel, consists first in taking away the impurities with which it is combined when found in nature, and next in rolling or drawing it down to the form in which it can conveniently be made use of, such as bars, rails, sheets, and rods.

As in the matter of the working of collieries, electricity comes in at every step in the process of iron or steel making to perform some of the work, and though it has not gained such a complete ascendency as in the case of coal mining, it is making rapid progress, has attacked problems that would not have been attacked in coal mining under the conditions, and even threatens to revolutionise the whole method of the manufacture of iron.

When the ore is shipped into the steamer that is to transport it to the furnaces it is, in many instances, now handled by means of an electric crane, and when it is unshipped it is often taken out of the ship's hold on to the wharf in the same manner. In America, also, the iron ore is often transported from the ship to the truck, and from an ore heap to a charging truck, by means of a rope haulage worked by means of an electric motor.

Arrived at the neighbourhood of the blast furnace, it is, at some ironworks, transported to the top of the furnace by means of a lift worked by one or two electric motors. The electric motors in this case take the place of the steam or hydraulic engine that formerly would have done the work, being geared to the last of the hoisting train in the usual way, but with special arrangements for control and for braking. In the case of the crane there are two electric motors, one of 50 horse power to work the hoisting tackle, and another of 10

**Iron and coal are the great fundamental materials of all manufacture. Any economy in their production is directly transmitted down the whole line of constructive and creative enterprise. It is of signal interest, therefore, to follow Mr. Walker's recent review of electric applications in the colliery with this discussion of the work of the newest form of power in the great allied industry—iron and steel making.—The Editors.**

horse power to work the turning tackle. In this case the pioneers of the crane movement did not make the mistake so often made in connection with new electrical appliances—they did not make the power too small for the work; consequently the cranes are a great success. It may be noted in connection with the electric cranes that are used for unloading ships that it has been found that the regular crane drivers, the men who had been used to drive the cranes by steam, made the best electric drivers.

Electricity has not entered into the Bessemer process, up to the present, except to take charge of the ingots after they have been run from the converter. In some works an electric crane takes them away to be stripped from their moulds, so that the latter can be used again with less delay than would be otherwise necessary. In the matter of taking up the pigs from the bed, the sow, as it is termed, electricity has not come in, though it might be used with advantage to lift them and bring them to the machine that is used to break them up ready for the open-hearth furnace. Electricity has come in indirectly, however, to assist the iron master and the iron founder in using up materials that would be otherwise wasted. In the Bessemer process there is a certain amount of waste in pouring the metal from the converter to the ingots. The slag, which remains in the converter after the charge has been poured out, contains substances that would be very deleterious to the steel if poured with it into the ingots; but it also contains a certain quantity of iron held mechanically by the slag. The slag is ground up in a mortar mill and passed through a magnetic separator, which delivers the iron by itself, ready to be used for working up again. Magnetic separators also play a very useful part in the iron-founders' and brass-founders' business, by separating the iron out from the brass and other materials which are often found in the lots of second-hand stuff the iron founder buys. They are also used to enable certain qualities of iron ore to be used that would otherwise not be available, and in the same manner, by separating the magnetic oxide of iron from the other substances with which it is mixed. So far has this been carried that it has been proposed and carried out in a small way to raise certain lower oxides of iron to the magnetic oxide, by the application of heat, and then to separate the magnetic oxide by the magnetic separator, only the magnetic oxide being attracted by electromagnets.

Magnetic separators are of very many patterns, and the problem is by no means the simple one that it seems to be. It is comparatively easy to extract large masses of iron from their surroundings, because

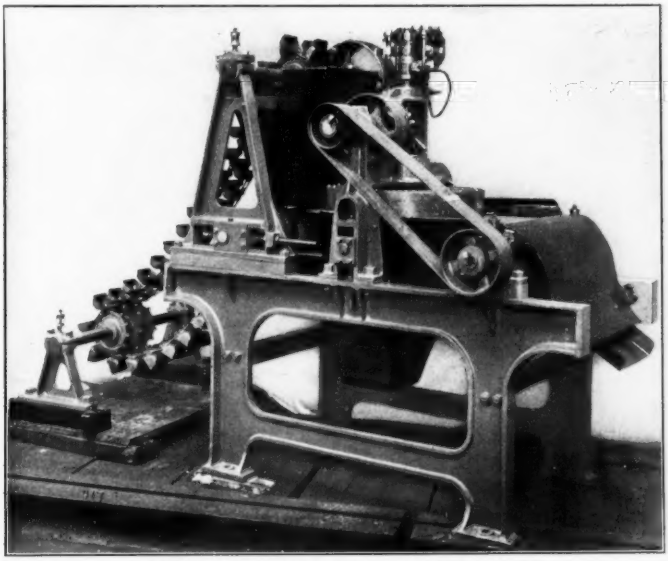
the iron itself takes part in the operation, becoming magnetised by induction; but when the iron to be separated, or the ore, is in a fine powder, the amount of attraction between the individual grains and the apparatus which is to hold them in the process of separation is very small indeed, and may easily be overcome by the cohesion of the other particles of the mass in which the grains are distributed; these grains may thus be carried away with the bulk of the material, instead of being delivered by themselves.

In a very beautiful form, and one that is most successful so far as my knowledge goes, the powdered substance in which the iron is embedded is led down a shoot over the surface of a revolving brass drum. On the inside of this drum electromagnets are placed, occupying a portion of the periphery, and the poles of these electromagnets are of opposite signs, round the drum. The electromagnets are very powerful, and are fed with current from the ordinary electric supply of the works, or where there is none, by a separate dynamo. As the powdered material passes down over the curved surface of the drum, the iron particles, or those of magnetic oxide, cling to the first magnet pole they reach; but on arriving at the next pole they turn over, attaching themselves to the magnet pole by the opposite end to that by which they were held to the first pole, and on arrival at the third pole the reversal is repeated, so that as the iron particles go round the drum they throw off any of the nonmagnetic material that may be clinging to them, and so the cleaning is very much more efficient. Though the electromagnets are necessarily made very powerful, in order to make up for the small mass of the iron grains, the whole power required is comparatively small, a nominal 15-horse-power engine being sufficient for the mortar mill which is used for grinding up the slag and for the dynamo furnishing the electric currents required to energise the electromagnets.

Another form of magnetic separator is in the form of a belt, which carries the material up to some electromagnets, where the iron is delivered to another belt, which again passes it to a separate heap.

For the open-hearth furnace a very beautiful apparatus has been worked out for the purpose of charging the iron into the furnace. Under the old plan the iron is fed into the furnace by hand, men standing at the open doors of the furnace and throwing through the furnace doors the pigs and other material of which each charge consists. In Messrs. Wellman-Seaver's plan a charging box is filled with the necessary quantity of material and brought into the neighbourhood of the furnace, a bogie truck bringing up a number of the

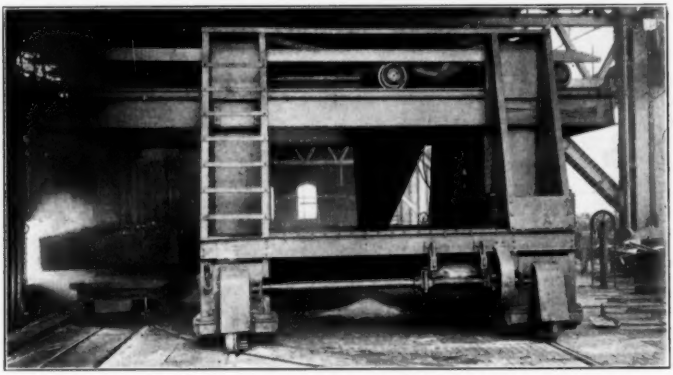
charging boxes which have been filled at another part of the works. On one end of each charging box is a socket, and into that socket fits a long bar, which projects from a platform slightly above the level of the furnace doors. The charging bar, as it is called, is hollow, and is locked, when in position in the socket of the charging box, by an inner bar, which is forced down into a place provided for it. Having grasped the charging box with its freight, the charging bar is raised up to the level of the furnace doors and forced through one of them.



A MAGNETIC SEPARATOR FOR USE IN STEEL WORKS.
By Messrs. Ernest Scott & Mountain.

When the charging box is in the right position, within the furnace, it is turned over by a revolution of the charging bar, its contents being emptied out into the furnace or distributed over the bottom of the furnace, as arranged by the man working the charging machine. When the box is empty, the charging bar is made to resume its normal position, and with it the charging box, which is then withdrawn from the furnace and deposited on its bogie truck ready to be hauled away for a fresh load. The whole apparatus is worked by electric motors, there being four in all, three of 25 horse power each for the lifting and traversing motions (the charging machine moves along the front of the furnace), and one of about 4 horse power for the twisting motion

of the charging bar when inverting the box. The maximum power consumed at any moment is given at 25 horse power, while the average power is stated not to exceed 10 horse power, though at the instant of raising the charging box off the bogie the maximum figures given are probably exceeded. All operations are controlled from a platform arranged for the purpose, placed in a position in which the operator

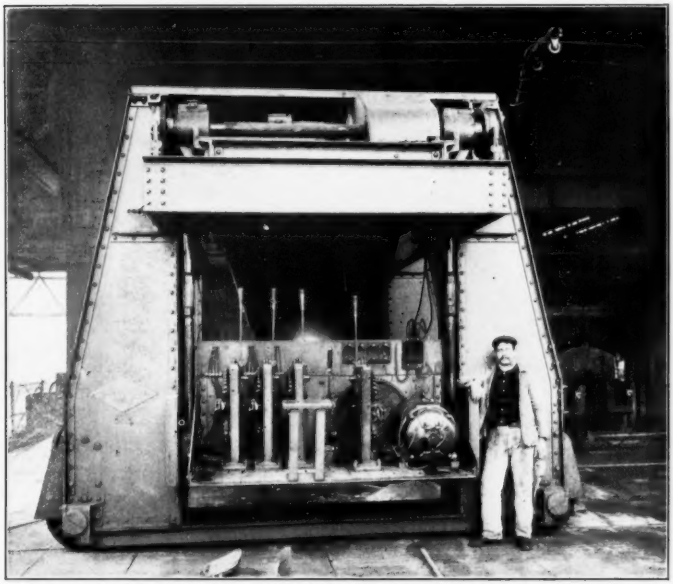


SIDE VIEW OF WELLMAN-SEAVER ELECTRIC FURNACE-CHARGING APPARATUS.
By courtesy of Jeremiah Head & Sons.

can see right into the furnace, and he has his switches and controlling gear close to his hand.

It is interesting to note that the first attempt to construct a charging machine for the open-hearth furnace was by means of hydraulic power, but it was not successful.

After being properly worked, the Siemens-Martin product is run into a kettle, just as the iron from the blast furnace and as the Bessemer product is, and from that is run into ingot moulds, which in some cases are taken away by an electric locomotive to the stripping house; there the steel ingot is released from its mould and the latter hauled back to the melting house, the ingot being taken to another part of the works, by means of an electric crane, for further heating before being worked up. Neither the rail mill nor the plate mill has yet been worked by electric motors, though every accessory is so worked. Thus electric cranes are used wherever a crane can be useful, and in addition a special form of electromagnetic brake is employed to prevent the cranes from lowering when not required; further, the plates and other masses of iron are lifted by means of electric cranes having electromagnets for the attaching arrangements, in place of



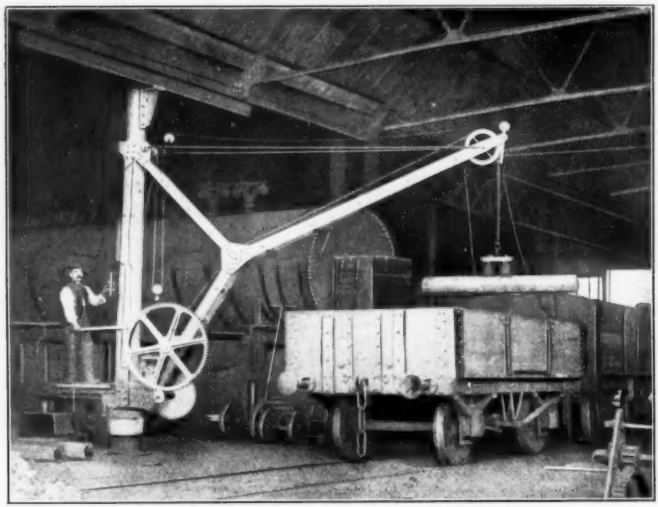
BACK VIEW OF WELLMAN-SEAVER ELECTRIC CHARGING APPARATUS FOR OPEN-HEARTH FURNACES, SHOWING REGULATING GEAR AND LEVERS.

By courtesy of Messrs. Jeremiah Head & Sons.

YARD OF AN AMERICAN STEEL WORKS, SHOWING CHARGING TRUCKS FOR OPEN-HEARTH FURNACE BEING TAKEN UP AN INCLINE WORKED BY ELECTRIC POWER.

hooks or other arrangements. Iron and steel lose their susceptibility to magnetism at a certain temperature, approximately 500° centigrade, so that they cannot be handled till they have cooled to that extent, and even then the power required to lift a given mass is largely in excess of that required when the mass is cold; but the convenience is very great, while the excess current would only be in use for a short time.

Those who have been through an iron works when rails or plates were being rolled will have noticed that in front of the rail, as it issues from the rolls, like a huge red snake, are rollers for it to slide over to and fro, these rendering the work of the men who are attending the mills very much easier, or, in fact, rendering it practicable. These rolls, in modern iron works which are electrically equipped, are set in motion by electric motors. Also the saws which cut the rails and bars to the lengths required, the tools, which grind the ends of the rails true, the drilling machines for the fish-plate bolts, the gear for lifting the rollers for the mills, all are worked by electric motors.



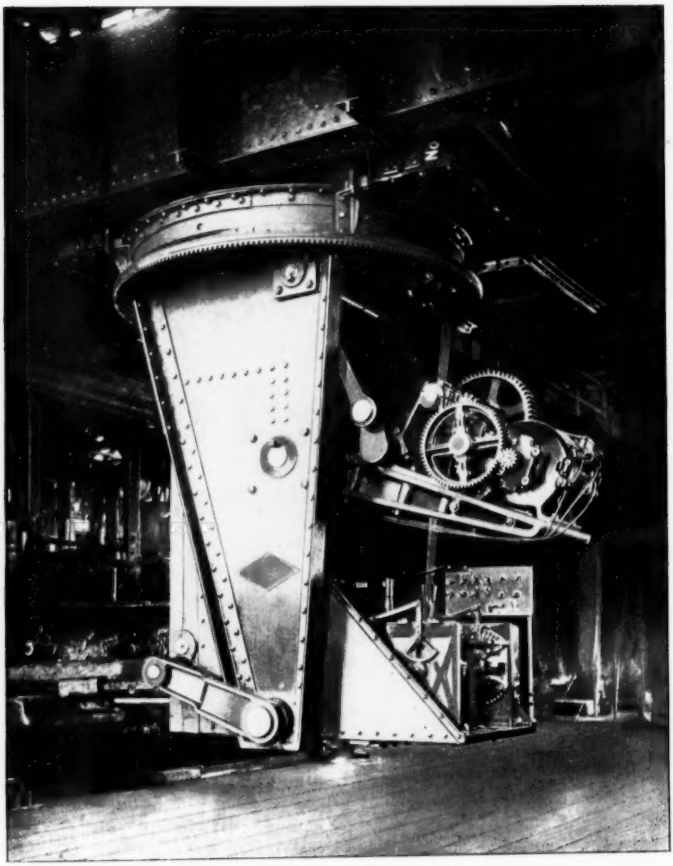
JIB CRANE LIFTING IRON WITH ELECTRO-MAGNETS.
Sandycroft Foundry & Engine Works Co., Ltd., Chester.

For practical purposes it may be taken that whatever can be done about an iron or steel works with a motor or a number of motors whose individual ability does not exceed 50 horse power, is now so worked in the most modern of works, particularly in America, which

MOVEABLE CRANE LIFTING AN IRON PLATE BY ELECTRO-MAGNETS.
Sandycroft Foundry & Engine Works Co., Ltd., Chester.

has led the way in this, as in so many developments of electricity. Above motors of 50 horse power the matter appears to be looked at still with considerable doubt by iron and steel manufacturers, and for the perfectly logical reason that if the motor is put to a piece of work that it is unable to master it stops and burns up, or blows its fuses, or throws its cutout, a nuisance in either case.

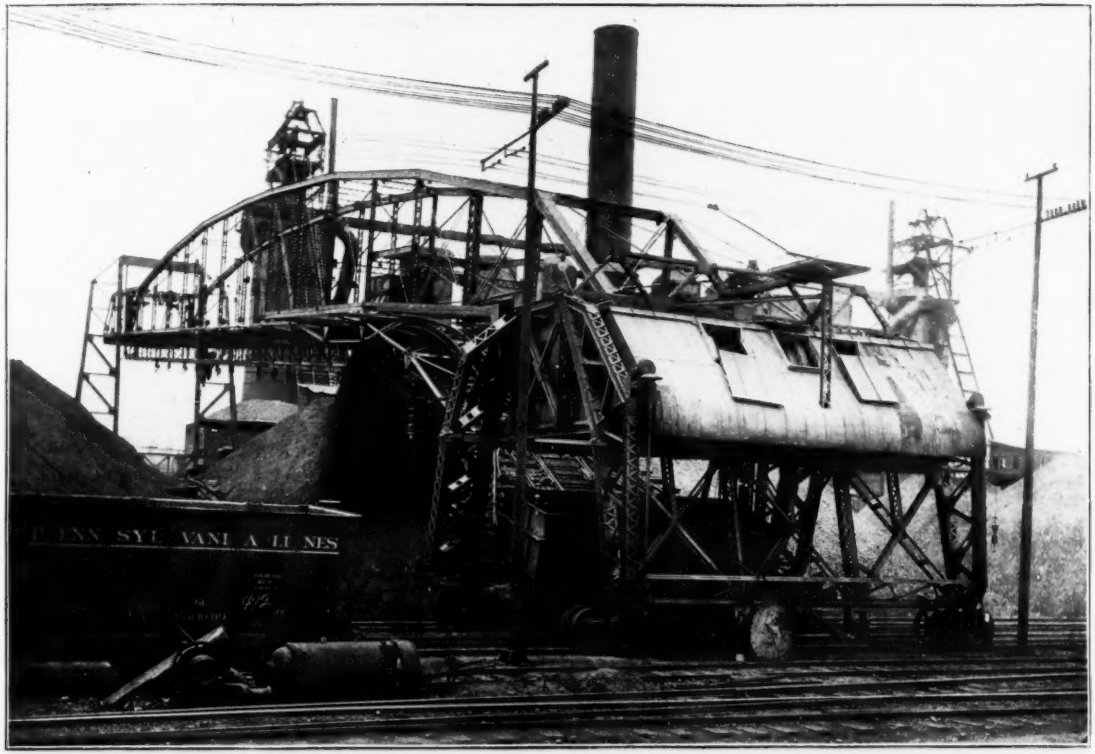
In my opinion there is really no ground for this apprehension, nor any reason, beyond manufacturing reasons, as applied to the motors themselves, why electric motors should not be employed with success in the rail and plate mills, and I have very little doubt that this will come to pass before very many years are over. The great objection is, of course, the old one—the terribly sudden strains that are brought to bear on the motor, whatever it may be that is in use, when the rail is first entered in the rolls; but this is a question that both English and



ELECTRICALLY OPERATED CHARGING CRANE, BETHLEHEM STEEL CO., SOUTH BETHLEHEM, PA., U. S. A.

Equipped by the Westinghouse Electric & Mfg. Co.

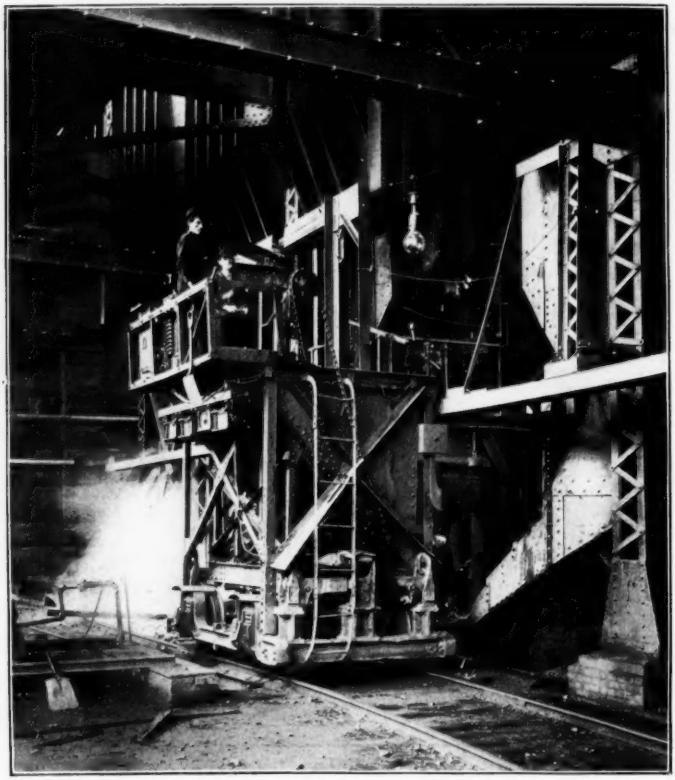
American engineers are fully qualified to deal with. The present engines must stand the strain, therefore the conditions should be known on the mechanical side of the problem, and the conditions on the electrical side are still easier to deal with, as electrical measurements are so much more easily made. The one thing to be remembered by whoever attacks the problem is that he must ascertain the *extreme* power that the motor may be called upon to exert, by actual



ELECTRICALLY OPERATED ORE BRIDGE, NATIONAL STEEL COMPANY'S WORKS, YOUNGSTOWN, OHIO, U. S. A.

A gantry crane of 250 feet span, weighing about 750,000 lbs., built by Webster, Camp & Lane Machine Co. and equipped with two General Electric 130-horse-power motors. There are two tracks—an upper one for cars used in stocking ore, a lower one for the trolley used in scooping; power for both purposes is transmitted by wire ropes. The car weighs 7,000 lbs., and load 34,000 lbs., the scoop bucket weighs 6,000 lbs. and ore 20,000 lbs. About 20 buckets per hour is the capacity. The best record is handling the contents of 134 railway cars in 12 hours.

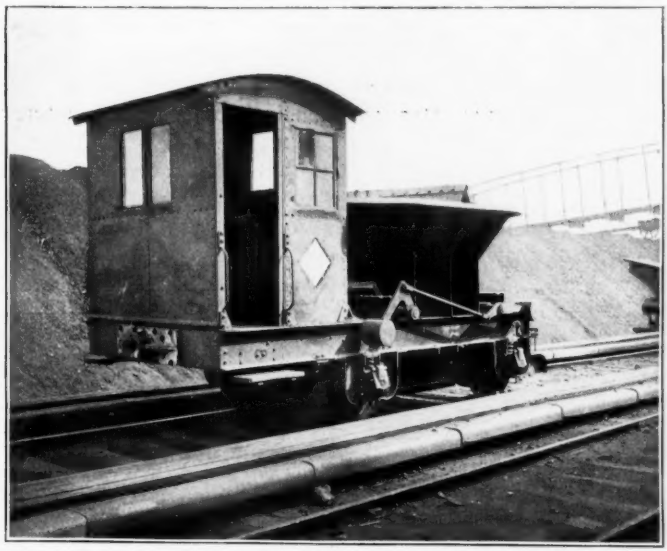
measurement upon existing plant, and he will be wise if in the motor or motors that he puts to do the work he provides a very large margin, over and above this. Then he will, in all human probability, be successful, and the work will be done more economically than at present, for the same reasons that electric motors are more economical in other places. Size should not frighten engineers, and the motors will use little more power for being above their requirements. In too many instances the power applied to perform a given work, when it is to be done by electric motors, has been that which it was calculated in the



ELECTRICALLY OPERATED BIN-FILLING CAR, NATIONAL STEEL COMPANY.

This car takes ore from the ore bridge shown on page 867, making a trip for each bucket scooped, running over the bins and depositing its load in the proper bin. It is operated by a General Electric motor of about 75 horse power, weighs 20,000 lbs., and can make a speed of 10 miles an hour.

drawing office *ought* to do it, without the usual check which a practical test gives and which can now so easily be applied by means of the motor itself. It cannot be too strongly insisted upon that there is no reason why an electric motor, any more than any other, should stop if it has or can obtain the power it requires to do the work in front of it;



ELECTRIC-DRIVEN SCALE CAR, NATIONAL STEEL COMPANY, YOUNGSTOWN, OHIO.

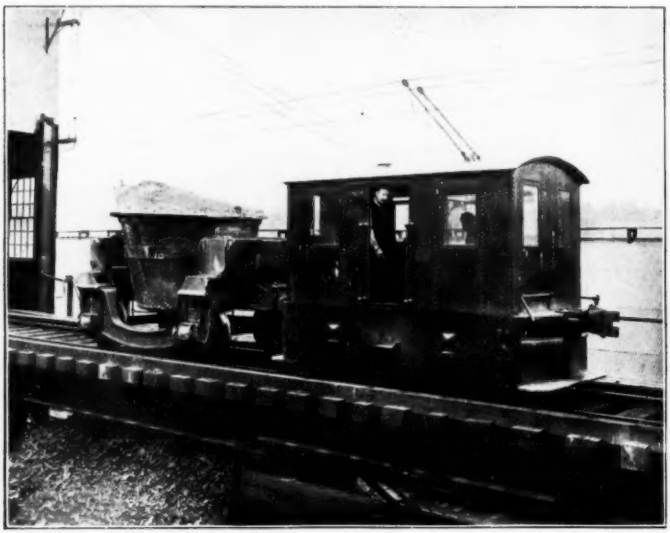
This car carries ore, mixed in the requisite proportions, from the bins to the skip bucket, which in turn delivers it to the furnace, being electrically operated and automatically controlled. The scale car weighs 18,000 lbs., takes a load of 16,000 lbs., and can attain a speed of 15 miles an hour when the distance is long enough to allow full acceleration. It is operated by a General Electric motor of about 27½ horse power.

the only precaution necessary—the principal one, at any rate— is to see that there is plenty of power available in the source of current and that the motor is capable of absorbing and converting the extreme power it may be called upon to deliver. Sanguine estimates are always the forerunners of trouble, in whatever matter they are taken. An electric motor is as good-natured as most motors, but the user always suffers for over-working it, and the principal difference between it and steam or other engines in this respect is that the user generally suffers earlier with the electric motor than with the others, which is, in many cases, to his ultimate advantage.

The electromagnetic brake described is another pretty application

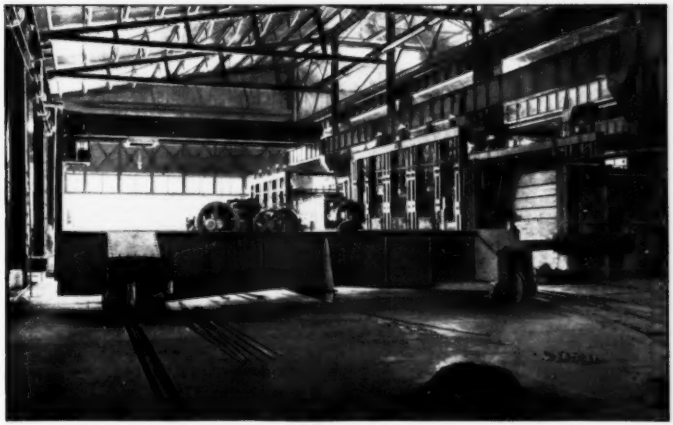
of the flexibility of electric apparatus. It consists of a number of discs strung on the armature shaft of the motor the brake is to control. Half of the discs are stationary, and the remainder revolve with the armature, the stationary discs being secured to an outer casting provided for the purpose. The casting also holds a very strong spiral spring which bears upon the discs, and locks them together so that the armature cannot revolve until they are released. In the casting is also fixed an electromagnet, which acts in opposition to the spring, by attracting the stationary discs and thereby releasing the discs which are connected to the armature and allowing them and the armature to revolve. When a current of certain strength passes through the coils of the electromagnet the discs are attracted and the armature released, and immediately the current falls below that strength the armature is locked. In the case of an accident involving the cessation of the current the motor is effectually braked.

The electric furnace, in which the arc formed between two carbons



ELECTRIC LOCOMOTIVE FOR HANDLING LADLE CARS, NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO

Used to shift ladles of hot metal in the mixer house, where the entire furnace output is taken. An average load is five ladles, each weighing 38,000 lbs. and carrying 40,000 lbs. of metal. The speed is three or four miles an hour, 500-volt motors being used to get the slow speed without gearing. Two motors are placed on each locomotive. The power varies from 23½ horse power, light, to 105 horse power with 6,600-lbs. draw-bar pull. Equipped by the General Electric Company.



ELECTRICALLY OPERATED FURNACE CHARGER, CARNEGIE PLANT, HOMESTEAD WORKS.

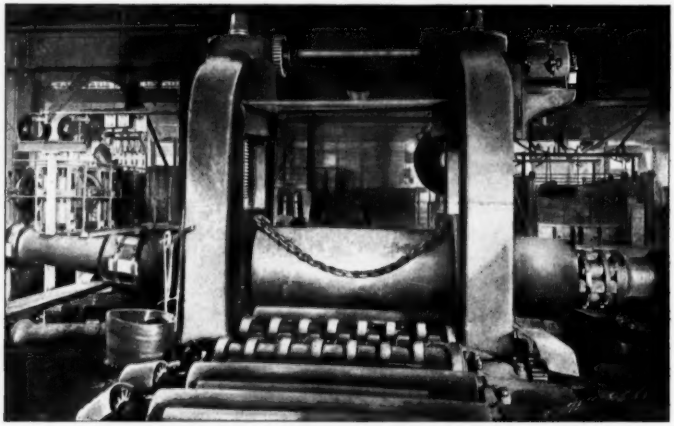
Westinghouse Electric & Mfg. Company's direct-current motors.

is utilised for melting metals and refractory substances, has not come into use for iron works up to the present. There is a possibility, however, of iron being made from the ore without smelting in any form, as it is now understood. Mr. Cowper-Coles, who has done so much with the electric furnace, has also been experimenting upon the process of building up iron from a solution of the ore in somewhat the same manner as he now builds up copper tubes, though not necessarily in the form of a tube, and as electrical energy can be obtained from any convenient source of power, this would mean the complete revolution of the methods of production of iron and steel.

Light is also required for the various operations that have been described, as many of them have to go on all through the twenty-four hours. The electric light is largely used, and has been ever since the advent of the Brush arc-light system. The beds on which the molten metal is run out from the blast furnace, the back of the blast furnaces, the tops of the furnaces, the yards of the iron works, the neighbourhood of the Bessemer and of the open-hearth furnaces, the engine houses—all require lighting at night.

For the yards, the furnace beds, and the neighbourhood of the Bessemer and open-hearth furnaces, and the rail mills, the arc light is usually employed, while for the engine houses and for the tops of the furnaces, where the spaces are confined, incandescent lamps are

used of sizes varying from 16 candle power to 500 candle power. At one time the arc lamps were displaced by the large incandescent lamps altogether, because the latter gave a light that could be depended upon, even if it was smaller for a given expenditure of energy, and cost less to maintain. Since then, however, the large incandescent lamp has not improved—if anything, it has gone back—while the arc lamp has very considerably improved, and in the enclosed lamp are combined most of the advantages of both forms; hence the enclosed arc lamp has taken the place which the large incandescent lamp had acquired at iron works, about the yards, etc. The matter of the cables about an iron works is a source of some anxiety to the electrical engineer, who is responsible for the successful working of the plant.

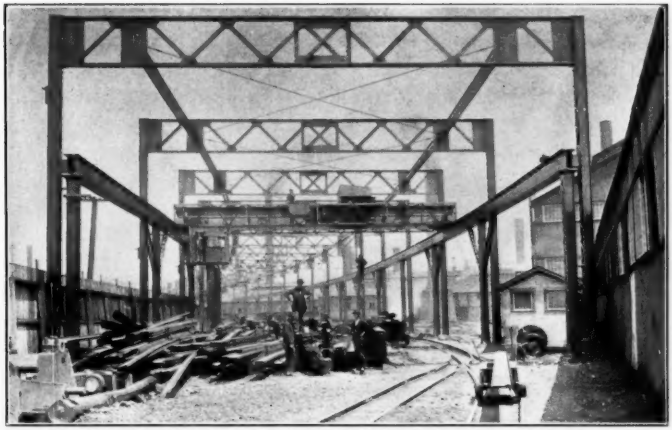


ELECTRIC MOTORS APPLIED TO RAISING AND LOWERING ROLLS, PARKGATE IRON & STEEL WORKS, LIVERPOOL.

Westinghouse direct-current "steel-mill" motor equipment.

There is always a considerable quantity of dust about an iron works, coming from the ore and the iron in its various operations, that settles upon the insulating envelope of the cables, and with the wet, the vibration that is always present in any works, and the assisting action of the electric pressure that exist in the cables, the insulating properties will gradually be destroyed. India-rubber has so far been used very largely for the insulation of cables about iron works, though vulcanised bittite has also been employed.

The great cause of failure in the matter of cables has been the exercise of too great economy—false economy—in the amount of india-rubber that has been put on the cables. In many instances, in



ELECTRIC APPLIANCES FOR HANDLING BEAMS FROM 33-INCH MILL, HOMESTEAD STEEL WORKS.

The peculiarity of this construction is the arrangement of the crane to travel on a curve, so as to utilise ground lying along the railway siding.

GENERAL VIEW OF ELECTRIC APPLIANCES FOR HANDLING BEAMS, HOMESTEAD STEEL WORKS OF THE CARNEGIE COMPANY, MUNHALL, PA., U. S. A.

Above are seen the travelling cranes; below, on the left, is the travelling table for carrying beams from the yard to the cutting-off saw.

the United Kingdom, at least, a wrapping of pure rubber has been thought to be sufficient, as the cable was in the open; but the action of rain, followed by heat, with the deposit of dust that has been mentioned, has been forgotten, and so leakage currents have been set up at each support of the cable, which have destroyed the insulation at those points, and the process of deterioration has gone on till there has been serious trouble from connections between the conductors and the iron work of the plant. The whole trouble, as usual, might be avoided by the provision of cables covered with a thick coating of vulcanised rubber, overlaid with some substance, such as yarn, that will protect it from the action of the wet and the friction of the metallic masses that it is practically impossible to keep it clear of; but the wrapping should also be of good thickness, and the cables should be overhauled periodically and any damaged places repaired.

The generating station for an iron works differs very little from that for a colliery, except that the former, at present, is usually larger.

The same question arises as to whether the lighting plant shall be separate from, or shall form a part of, the power plant. In answering the question a good deal depends upon the extent and the form of the lighting. Where the lighting has been done with arc lamps for a number of years before the advent of the power plant, if it is still usable and efficient, it is often the practice to allow it to remain, driven by its separate engine; but in most modern iron works the amount of lighting has far outgrown the old Brush plants, good servants as many of them have been, and the question is rather one as to how the arcs, when there are many, shall be fed with current. If the works are very extensive, it may be economical to adopt the old series system, especially where all of them will be in use all and every night. But in by far the greater number of cases, either the simple parallel system, in which each arc takes its current direct from the supply cables, just as incandescent lamps do, or the series parallel system, in which a group of lamps (two or four) take their current from the supply cables, will be more convenient and more economical. Where the simple series system is adopted, with a very large number of lamps—say sixty or more—in series, the machine to furnish the current for them must be a series arc-lighting machine, and must be driven by its own engine, or by a separate belt from a countershaft driven by the engine which is driving the other machine. With the simple parallel system, or the series parallel systems, the lights can be taken off the power supply cables if desired, but in my opinion it is better to have entirely separate plant for the two services, and for the same reasons that I gave

ELECTRIC CRANES HANDLING BEAMS AT THE PLANT OF THE EISEN UND STAHLWERK HOESCH, DORTMUND, GERMANY.

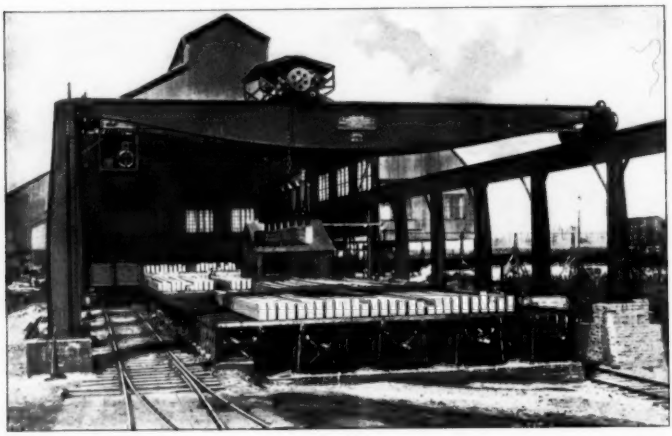
Effective travel of trolley 48.5 meters each way from center—97 meters altogether; capacity throughout the entire length, 5 metric tons. Speed of trolleys 250 meters per minute, of crane along track 90 meters per minute, of hoisting with full load 60 meters per minute. The legs of the crane are far enough apart to allow beams 15 meters long to be carried through without interference. All functions are operated by a single 500-volt direct-current motor. Brown Hoisting Machinery Co., Cleveland, O., U. S. A.

for the opinion in my article on electricity in collieries,* viz.: there may be considerable fluctuation in the pressure of supply of the power service, as machines are put on or taken off, which no governor will compensate for quickly enough to avoid unpleasant blinking in the lights. In addition, it is possible to economise considerably in the cables for a large power service by adopting pressures of supply that would be exceedingly inconvenient for the lighting service, as it would necessitate a very large employment of the series parallel system in the lamps, and the consequent turning in and out of lamps that it would not always be convenient to have worked in that way.

The only question remaining to be discussed is the form of the current. In all the iron works that established electrical plant for lighting and power in the United Kingdom up to a few months ago continuous currents were employed, and the motors were nearly always shunt-wound, the generating plant consisting of one or more four-pole or six-pole dynamos, driven by compound engines; the later plants, however, have some of them been laid down on the polyphase system, and there seems every prospect of that system being very largely adopted. It has the enormous advantage that the motors, which must necessarily be placed in all sorts of positions where they will be subject to rough usage and to conditions which will tend to make the commutators form flats and spark, have no commutators, and can be completely enclosed without the necessity of overhauling that is

* THE ENGINEERING MAGAZINE, Aug., Sept., 1900.

necessary with the enclosed continuous-current motor. It has now been proved, also, that the polyphase motor has all the self-regulating properties that the continuous-current motor has, and in a higher degree; its one failing, if it be a failing, being that it will not stand more than a certain percentage of overload. This really means only that a larger motor is to be fixed where it is likely that an overload will have to be met if a polyphase system be employed than if the continuous-current system be employed.



ELECTRIC TRAVELLING CRANE WITH LIFTING MAGNETS, OHIO STEEL COMPANY'S WORKS, YOUNGSTOWN, OHIO, U. S. A.

Operated by Westinghouse direct-current motors.

In my opinion this is a fault that might very well be encouraged. Too many plants are put down with apparatus very close, in their capacity for work, to the work they have to perform day by day, with the result that when extra work is met with, in the form of friction and the like, the apparatus becomes a source of trouble.

The polyphase system has also the disadvantage that three wires are necessary for distribution, but that is not serious with a careful engineer and careful hands under him.

# AUXILIARY STEAM AND WATER APPLIANCES FOR WATER-TUBE BOILERS.

*By B. H. Thwaite.*

IT has been demonstrated that the evolution of the water-tube steam generator has now reached a stage that securely fixes its position as the agent *par excellence* for converting heat into motive power in steam engines, and especially for naval purposes. The undoubted imperfections associated with the pioneer forms of the water-tube steam generator, especially of the large-water-tube type, have provided weapons for its more or less prejudiced enemies, and only by the removal of the defective types will the power of the opponents be destroyed and general confidence be secured.

The existing stage, of securing confidence after the incidence of partial failures, is a critical one; but it is common to the history of all great innovations on established procedure. The supervision of the water-tube type of steam generator requires a higher intelligence to secure economy than is necessary for the shell type. It is well-known that all the instruments of applied science require, and in increasing measure as they approach perfection, a higher degree of intelligence in the character of the supervisor and his associated workmen. The era of change is naturally a trying one, but corresponding difficulties have over and over again been met and solved in the progress of mechanical development, and the invariable result has been improvement, both in the character of the work performed and the character of the personnel employed upon it. In the case of the water-tube boiler, moreover, much thought and ingenuity have been expended by designers in equipping their boilers with automatic feed-water regulators and efficient steam separators, which aid the men in charge as much as possible in securing steady and satisfactory work from the boilers without overtaxing strain in their management.

The supreme importance of dry steam is sufficiently recognised

It is not uncommon in mechanical development to find success or failure hinging upon an apparently very minor problem, rather than upon solution of what appears to be the main issue. The water-tube boiler instances this peculiarity, in the great importance which attaches to the devising of means merely for regulating the water supply and for taking away dry steam. The interest awakened by Mr. Thwaite's articles on the Water-Tube Boiler for Naval Service, published in this Magazine in November and December, 1900, assures the value of this study of effective means for meeting the supplementary requirements of the coming type of marine steam generator.—THE EDITORS.

and requires no further emphasis. In water-tube steam generators the rapid circulation of the water and its admixture with steam *en route*, often tend to the production of very undesirable priming effects. If the generator tubes are what is technically termed "drowned" (or

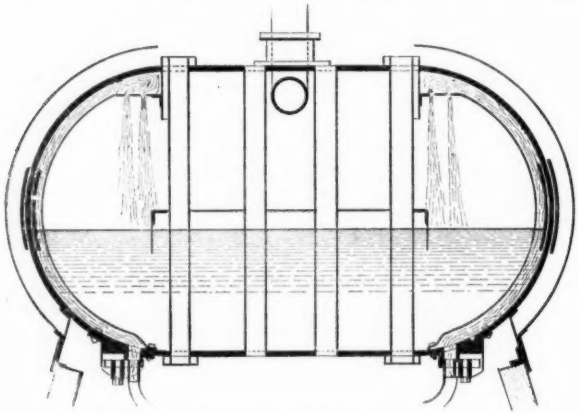


FIG. 1. ORIGINAL APPLICATION OF WIRE DRAWING PRINCIPLE.

contain water throughout their entire length) the violent expulsion of steam and water through their upper outlet ends will produce a disturbing effect on the water contents of the steam-and-water drum and there will be a decided tendency in the direction of priming and towards the production of wet steam. Thornycroft recognised this, and arranged his generator-tube upper terminals at a position above the water-level in such a way that the water part of the mixture ejected from the tubes into the drum rained down onto the water contents of the drum, and the ebullition is therefore not so liable to produce priming effects and it is comparatively easy to effect the separation of the steam from the water. The principle underlying most of the arrangements adopted by most of the water-tube-generator makers for effecting the separation of the water from the steam may be termed one of aqueous coherence. The steam is projected against sheet-iron or zinc baffle plates, and the particles of water are held by the water already on the surface or flowing over it. Considerable ingenuity is displayed in the disposition and arrangement of the baffle plates, as

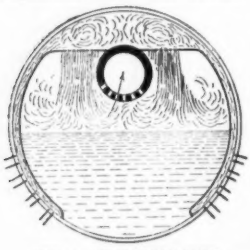


FIG. 2. WIRE DRAWING THROUGH APERTURES.

the figures to be described clearly shew. An alternative arrangement is the application of the wire-drawing principle, apertures of knife-edge dimensions or in circular form being provided, through which the steam and water are compelled to flow, the two being separated by a kind of filtration effect. Owing to the physical or density difference between the vapour and water, the former easily passes through the aperture while the water is left behind. The original application of this principle to water-tube practice is shewn in Figures 1 and 2; Figure 3 shews the application of the knife-edge wire-drawing system. A somewhat similar principle is adopted by Thornycroft in his suspended vertical grid device (see Figure 4). It will be seen that he suspends, in a position fronting the tube ends, a sheet-iron baffle plate hung from the crown of the drum, which may carry in suspension a series of grids through which the steam is compelled to pass, as shewn by the arrows, on its way to the steam pipe.

FIG. 3. WIRE DRAWING BY KNIFE-EDGE APERTURES.

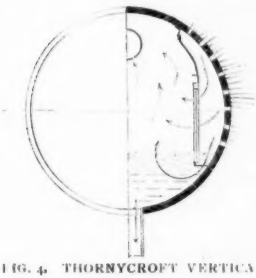


FIG. 4. THORNYCROFT VERTICAL GRID.

Another arrangement of Thornycroft's is shewn by Figure 5; the direction of the flow of steam is indicated by the arrows. A semi-circular baffle plate receives the steam and water ejected from the tubes, the lower edge of the baffle plate reaching to the normal level of the water in the drum; the edges of the baffle plate in contact with the water may be formed of zinc. Figure 6 shews the arrangement adopted by M. Niclausse; it consists of an ingenious disposition of baffle plates well-contrived to effect the separation of the water from the steam; the position of the feed water inlet and also that of the

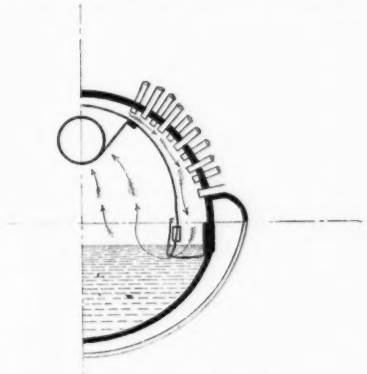


FIG. 5. THORNYCROFT BAFFLE-PLATE SEPARATOR.

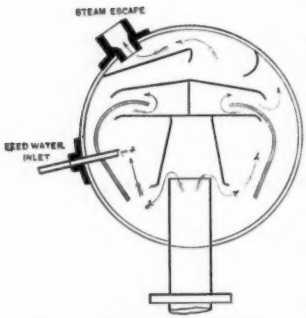



FIG. 6. NICLAUSSE SEPARATING DEVICE.

steam outlet are shewn. Du Temple's arrangement is shown in Figure 7. It consists of an inclined baffle plate facing the outlets of the nests of the generator tubes partly submerged in the water. The effect of this baffle plate is to prevent the steam from carrying into the upper steam space the water ejected with it from the tubes.

Another arrangement of the baffle plate is shewn in half-section by Figure 8. This plate extends across, and may also extend to, nearly the full length of the drum, or it may be a finely perforated plate. In both instances the water is retained on the underside of the plate, from which it eventually falls by gravity onto the surface of the water in the drum. This Figure 8 shews an arrangement of suspended zinc plates, having for its object the preservation of the baffle plate and the internal plate surface of the drum. It is arranged to be in contact with the surface of the drum near the water line. It is this part immediately above and below the water line that is most subject to corrosion.

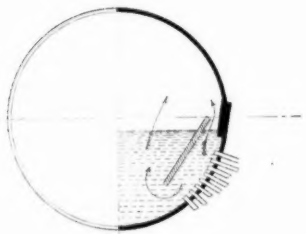


FIG. 7. DU TEMPLE'S ARRANGEMENT.

Figure 9 shews such a striking innovation from the established practice that it must be described. It will be seen that the water rises into a central tube in the steam space. This tube has on its underside a series of perforations through which the water, separated from the steam, can fall either onto the water level or onto an intervening trough, both arrangements permitting the easy escape of the bubbles of dry steam.

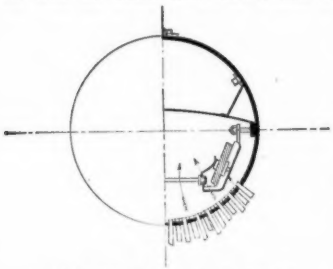


FIG. 8. ANOTHER BAFFLE-PLATE DEVICE.

Besides the baffling arrangements described, an auxiliary apparatus is often located between the

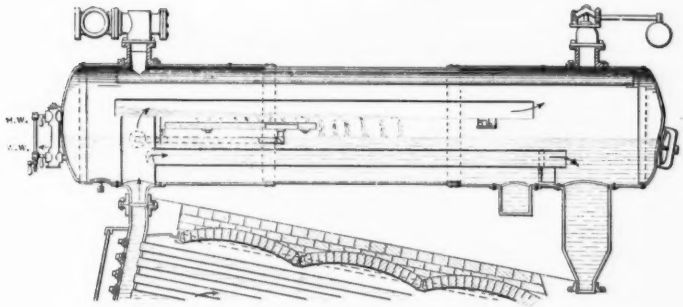


FIG. 9. SEPARATION BY MEANS OF PERFORATED TUBE IN STEAM SPACE.

steam generator and the steam engine, somewhere in the line of the steam pipe, which not only automatically separates the steam from the vapour, but ejects the resulting condensed water; Figure 10 shews clearly the working of this apparatus, the flow of steam being in the direction indicated by the arrows. In forcing its way through the grid (A) it is wire-drawn and the suspended water is separated on the under side of the grid, eventually falling to the bottom of the vessel, where it gradually accumulates until it attains such a depth as to lift the float B. The movement of this float, with the associated lever C, opens the ejection discharge valve D; the water is then forced out and the balance weight E recloses the valve D. The water discharge can also be effected by hand. It is advisable that the apparatus should be made of gun or other incorrodible metal.

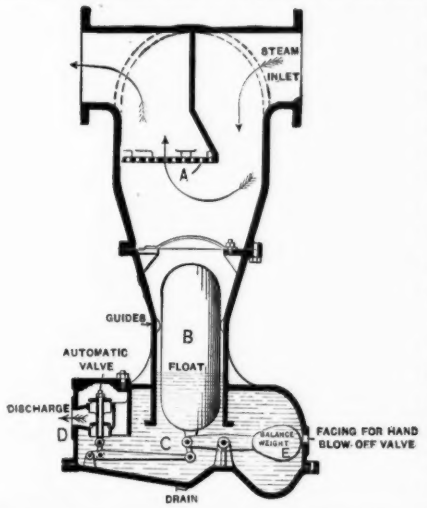


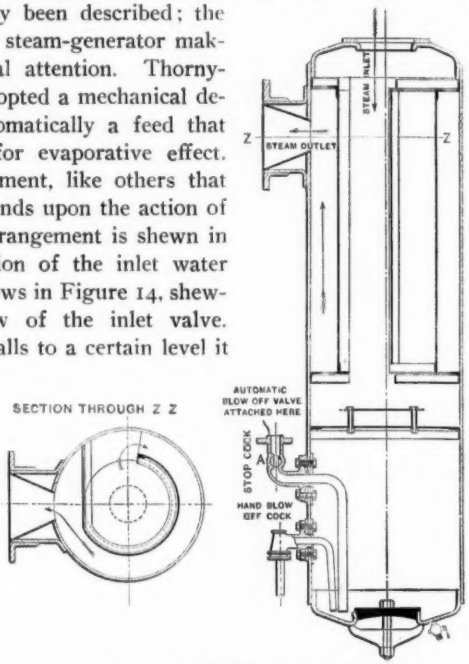

FIG. 10. SEPARATING APPARATUS IN STEAM PIPE.

Belleville's auxiliary cylindrical separator is shewn in Figures 11 and 12, the direction of the steam passing through the apparatus being shewn by arrows. A circular division plate intervenes between

steam inlet and outlet. It has closed ends and an opening on one side, as shewn in horizontal section, Fig. 11. The water accumulates at the bottom of the vessel, and when it attains a certain height a float lifts an escape valve and the water is forced out. I have already strongly emphasised the importance of using dry steam, and the steam-pipe connections between steam generator and steam engine should never be permitted to act as condensers under any conditions; adequate jacketing should be provided to prevent this. My own system consists in the employment of a special oil or glycerine which is heated up to the temperature of 350° F. This fluid circulates not only through the jacket, but through a special tube placed in the centre of the steam space itself.

Turning now to automatic feed-water regulators, we come upon a field in which much more study has been expended upon the small-tube than upon the large-tube boiler.

Belleville's arrangement for automatically supplying his generator with water has already been described; the other large-water-tube steam-generator makers rely upon personal attention. Thornycroft, however, has adopted a mechanical device for securing automatically a feed that exactly compensates for evaporative effect. Thornycroft's arrangement, like others that will be described, depends upon the action of a float: the general arrangement is shewn in Figure 15, the direction of the inlet water being indicated by arrows in Figure 14, shewing an enlarged view of the inlet valve. When the steel float falls to a certain level it opens the inlet valve, an arrangement of levers permitting this action; the feed water flows into the water drum until the normal water level is obtained. The counterbalance weight closes the valve when the influence of the float is re-




FIGS. 11 AND 12 BELLEVILLE'S AUXILIARY CYLINDRICAL SEPARATOR.

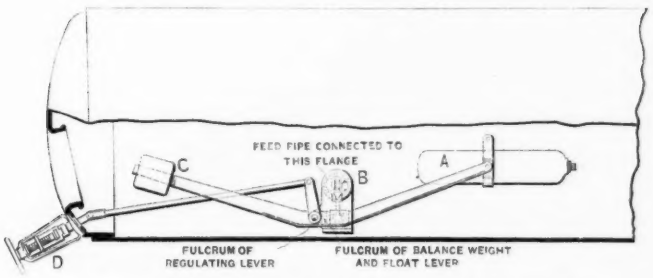



FIG. 13. THORNYCROFT AUTOMATIC FEED-WATER REGULATOR.

moved. The arrangement is also regulated by means of an externally placed hand wheel. In Figure 13 the float of steel is marked A, the feed-water valve B, the counterbalance weight C, the hand regulating wheel D. Yarrow, like Thornycroft, places his automatic feed gear inside the steam-and-water drum. It may be stated here that Yarrow does not on principle advise the employment of automatic feed arrangements. He considers they carry more danger with them than is compensated for by their advantages. Yarrow's arrangement is distinct from those already described; the action depends, of course, upon the rise and fall of the water in the steam-and-water drum. If the water falls below its

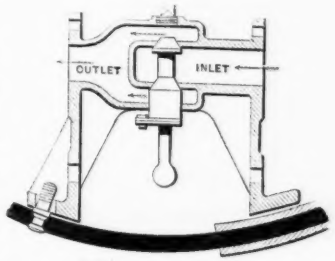



FIG. 14. ENLARGED VIEW OF THORNYCROFT INLET VALVE.

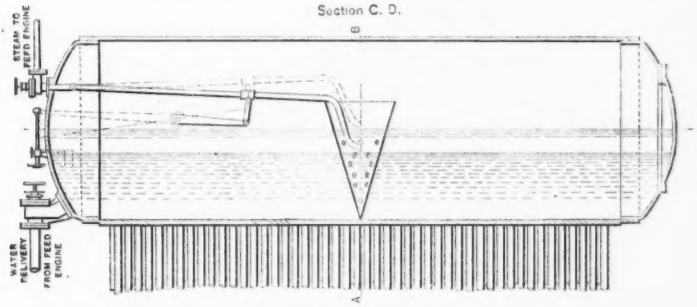



FIG. 15. YARROW AUTOMATIC FEED-WATER REGULATING SYSTEM.

proper level, steam enters a pipe leading to a pumping engine, which is actuated at a high velocity until the water in the generator is raised to the proper or normal level. When the water reaches the orifice of the internal steam pipe which delivers steam to the pump, water flows along this pipe to the pumping engine and the pump works hydraulically, rapidly slowing down in speed. Provision is made for raising and lowering the internal steam pipe leading to the steam pump, in order to adjust the level of the orifice of the former and to satisfy the conditions of any height of water and method of working; the exhaust steam from pumps is directed into the feed suction and consequently acts as a feed heater so that there is little thermal loss. If steam is used when the pump is working hydraulically, the hot water is simply taken from the steam generator and passed to the condenser through the escape valve. It will be seen that not only is the water, if below the normal level, rapidly raised to its proper height, but if the water is too high it automatically falls to the proper level. The figures are explanatory.

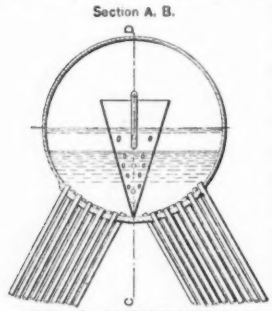



FIG. 16. YARROW SYSTEM.

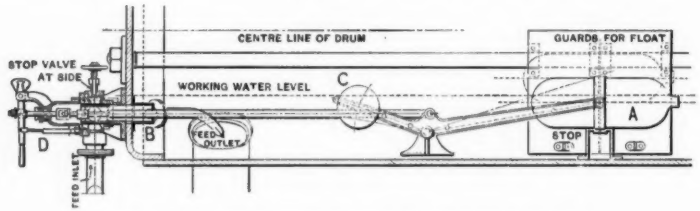



FIG. 17. LAIRD'S AUTOMATIC FEED-WATER-SUPPLY DEVICE.

Figure 17 shows the arrangement adopted by Laird for automatically feeding the Clyde water-tube boiler, one of the many modifications of the types of small-water-tube generators described. It will be seen to be similar in character to Thornycroft's, the disposition of the levers and the fulcrum being, however, different. The other modification is in the feed inlet valve, which is of the circular-piston form and is placed externally, giving visual indications of its condition of opening or closing. The inlet valve is regulated by hand.

# THE QUESTION OF THE COST OF HIGH-SPEED TRAINS.

*By Charles Rous-Marten.*

T may be as well to state plainly at the outset that, in considering the question whether high speed pays on a railway, I have no intention of inflicting on my readers huge masses of indigestible statistics. Voluminous tables of figures are sometimes useful and occasionally instructive, but they provide the dullest of "dry" reading, and the object aimed at can be attained just as surely by means less painful to the reader. A better plan, I venture to think, will be to view the question from its practical aspect in the light of the salient general principles which may seem to have been established as the result of definite experience.

Now, in seeking to answer the question which forms the title of this article, we are met on the threshold by another question necessarily precedent to the solution of the problem. That is: What *does* it cost to run fast trains? And before we can tackle that problem with any hope of success we find ourselves compelled to be clear in our own minds what items go to make up the actual cost and the excessive cost—if the later exist—of high speed.

Here the enquirer promptly encounters a whole army of confused and contradictory opinions. But he will almost certainly find in the forefront of this army the confident allegation that *"high speed involves increased consumption of fuel."* Does it? I will take that point to begin with. Why should increased speed involve augmented consumption of coal? Mr. Delano set himself, some months ago, to answer the whole question, but, as Mr. Angus Sinclair justly remarked, in the result he merely stated the problem which still remains unsolved. It is, of course, quite easy for flippant frivollers to interject offhand in their delightfully cocksure and question-begging style: "Why, of course, if you run faster you must use more steam, and if you use more steam you *must* use more coal!" Surely the *non sequitur* is

Mr. Rous-Marten's review is a striking presentation of the idea that intensified production is the absolute requisite of economy, just as truly when the thing produced is transportation as when it is mechanical apparatus. "The largest result in the shortest time" is the goal of modern industrial effort. The ultimate saving enormously repays the incidental expenditure. "Time is the one thing whose loss is absolutely irreparable."—THE EDITORS.

apparent. Does not the necessity of burning more coal depend very largely on the load you have to haul, and the road over which you have to haul it? If this be admitted, and as a matter of truth and honesty there is no alternative, then it is conceded *ipso facto* that there are other elements than that of mere speed to be taken into consideration. For example, would it use more coal to run on the level a 50-ton train at 60 miles an hour, or a 300-ton train at 55? Or would it cost more in fuel to haul a train *up* a one per cent. grade—1 in 100—at 50 miles an hour, or *down* at 75? No educated person, whether a professional engineer or not, will hesitate for one moment to answer in each case negatively. So then, ignoring for the present all other conditions, we are brought face to face with the plain fact that increased speed is only one of at least three elements that have to be taken into account, and that its influence on the whole question is absolutely relative to the proportional prominence of the other elements.

Having reached this stage in the investigation, I am enabled now to narrow down the issue in its first phase. Why should the haulage of heavier loads at higher speeds or up steeper grades involve increased consumption of coal? To this there is but one answer possible: Because the *resistance* is increased which has to be overcome by the engine. But then another query, and a very awkward one, thrusts its head obtrusively to the front: "What is the nature and amount and operation of the resistance encountered?" Ah, there we are faced by a puzzle which has hitherto proved insoluble. I am fully prepared for indignant counter-protestations. I am well aware that many various and discrepant solutions have been offered to the world, but as they *are* various and discrepant it is at least clear that each cannot be the true solution or the last word in the question. I am familiar with the earnest and able efforts made by Clark and others to settle the point definitely, and with their utter failure to achieve any approach to absolute finality. Even the latest proceedings of some eminent engineers with respect to atmospheric resistance show that the question of train-resistance is still in its infancy.

There are, however, certain broad facts with which one may deal in considering the whole subject from the practical viewpoint as distinguished from that which is merely academic and dialectic. Nobody will deny or dispute that *in certain circumstances* augmented velocity can be gained only at the expense of augmented coal-consumption. If you desire to force an express of a certain weight up a one-per-cent. grade at 50 miles an hour, instead of 40, you can only do so by means of increased power obtained through increased consumption of fuel.

That is quite clear. Everybody knows that and nobody disputes it. But is the case the same down a falling grade of 1 in 100? That can only be if we assume that high speed becomes more and more difficult as we descend a long one-per-cent. down grade, and that the resistance encountered becomes more and more severe the longer and faster we descend. But even the veriest tyro in railway matters knows that the reverse is the case, and that so far from increased effort being needed to accelerate the pace after some distance has been run at high speed down a falling gradient of 1 in 100, the engine-driver usually has to shut off steam and often to apply the brake slightly or moderately to prevent undue acceleration, that is to say beyond the limits fixed. Manifestly, then, his sole consumption of fuel at all would be in such a case for the working of the brake to reduce his speed, not for any purpose of augmenting it.

I have taken a one-per-cent. grade as a convenient arbitrary datum, but obviously the same rule would apply to other gradients, with more force the steeper, less force the easier they might be. But now let us take the absolute medium between the rising and the falling grade—the dead level. Is it a fact that fuel-consumption increases *pari passu* with increase of speed on an absolutely level line? Those theorists who delight in the Montague-Tigg kind of formula, "a figure of 2 and as many 0's as the printer can get into the line," will instantly trot out their pet hack, the formula that "*the resistance of trains increases as the square of the velocity.*" To this I rejoin that it may do so in certain cases, that is to say, in certain circumstances and under certain conditions, but that the amount of resistance is not fixed and unalterable; it varies as do the conditions under which it is run. It is not proved and never has been proved that under all conditions the resistance of a train increases with the increase of speed. I do not mean simply *pari passu*, but even at all. It is not established that in certain circumstances the resistance does not diminish in some degree as the velocity increases. Observe, I merely say, "it is not proved." Neither is the contrary. The entire question is an open one. But it is at least fairly open to doubt whether, after a particular velocity has been attained, the rate of increasing resistance, and even the amount of resistance itself, do not steadily decline. This has been found definitely to be the case in certain instances. Why should it not be so? The reply will be that every source of resistance is necessarily magnified by augmented speed. No; not necessarily, by any means. For example, on a falling grade you have the force of gravitation working in your favour instead of against you, as you have when you

are going up-grade. The head resistance of the atmosphere is virtually negligible. The side friction of the train against the air is not a formidable factor. Friction of the revolving parts and the shock of the reciprocating parts are doubtless enhanced in some degree, but to what extent is not authoritatively established, and even in these cases it has yet to be clearly shown that a very high rate of speed does not operate with regard to friction of parts, providing these be well designed and adequately lubricated, much in the same way as a skater skims over thin ice with safety if his pace be fast, whereas he breaks it and is submerged if he try to cross it slowly. Moreover, in this case and also that of the reciprocating parts, there are plenty of devices well-known to mechanical engineers by which these drawbacks can be minimised, if not avoided. If a high piston-speed be objectionable —which is at any rate a matter strongly in dispute—it can be lessened either by shortening the stroke or by enlarging the driving wheels. The shock of reciprocation is a greater drawback, but it always must exist in some degree, and there is no proof that its severity is proportionately enhanced as to its obstructive effect by augmentation of velocity. In fact, if that part of the alleged increased cost of higher speed which is due to more fuel being burned be caused by enhanced resistance, it is evident that this does not exist in the descent of fairly steep inclines, that its extent upon the level is dubious, and that it acts with certainty only in ascending up-grades, while here it is affected by various conditions outside of the speed question.

A contention is often based upon maritime experience of the large additional coal consumption which is needed to secure an extra knot per hour when a very high speed has been reached—that this must also be the case on a railway, and that every mile per hour above 60 or 70 is gained only at a cost in fuel far exceeding that by which an additional mile of speed would have been got at 40 to 50 miles an hour. But those who argue thus totally forget the essential difference in the conditions. A steamship has to force her immense bulk through a very dense resisting medium, which obstructs her bow and clings adhesively to her sides. There can be no valid comparison between such a condition of work, and those which obtain in the case of a train rushing through the rare and elastic air. Indeed, some comparatively recent experiments have afforded strong grounds for believing that when a train is flying along a level or slightly falling road at a speed of 60 to 70 miles an hour, it takes a comparatively small exertion of locomotive power to add materially to that speed, the main, if not the sole, obstacle to still higher rates than we have yet seen being

not the resistance of the train, or the friction of the wheels and of the revolving parts of the engine, or the alternate shock of the reciprocating parts, but simply *back-pressure,* the backward obstruction of the used steam in the engine cylinders.

Coal consumption forms the subject of periodical returns on most railways, but except as to its aggregate amount and to its amount per engine-mile, these returns afford little, if any, useful information. Certainly they furnish no guide whatever as to the cost in coal of high speed. Two English railways have often been instanced as cases of relatively small consumption of coal being associated with a specially high average of speed. It is retorted by those who believe increased speed to involve large augmentation of coal-consumption, that this smallness of coal consumption on those two lines was due to the superior excellence of the locomotive designs. Very likely; but if so, if it prove anything, it proves that the greater fuel-extravagance of other lines, proportionately to speed, was due to the locomotive designs, not to speed, and that if an engine be well designed it may burn no more coal per mile at 70 miles an hour than another of inferior design at 50. At any rate, it adds another to the numerous list of qualifying conditions that affect the question of the relations between high speed and proportionate consumption of fuel. It is entirely a matter of circumstances and conditions, not one of mere speed alone.

But it may be urged—has been urged—that high speed involves other excesses of outlay, such, for instance, as the cost of better permanent way, rolling-stock, and signalling apparatus, and higher wages to better officials. To this I should answer at once that a railway company compelled to incur these items of outlay on its main lines receives benefit rather than injury. It is all in the favour of a company to have the best possible road and rolling-stock and men and methods, and the system which pretends to secure economy by parsimony in this class of outlay usually results in the company having to pay very heavily sooner or later for its misdirected stinginess. In no case is the advantage of unstinted liberality in securing the highest excellence more pointedly manifested than in that of a railway. In lessened cost of repairs and reduced liability to accidents, with their resultant damages and compensation, the benefit of first-class plant and material and personnel is forcibly shown, and parsimony in any of these respects is the falsest of false economy indeed.

Another objection raised to high speed is that it causes delay to stopping passenger-trains and to goods traffic by necessitating much shunting to let the expresses go by. But this need not occur if the

line be capably and smartly administered. Passenger "slows" usually meet with delay because they are worked at stations in a dilatory manner, all smartness being reserved for the expresses. Get them away promptly and punctually, and they will neither block the expresses nor need frequent shunting themselves. As for the goods traffic, it can be dealt with in either of two ways. One is to double or treble or quadruple the road, as is much done in England; to work the goods traffic in small waggons and relatively short trains, using proportionately short sidings, etc., and to keep the "slow" trains constantly lumbered up. The other plan, as practised largely in America, is to employ engines powerful enough to haul huge trains of large waggons at good speed and controlled by continuous brakes, so as to get the traffic out of the way as quickly as possible. This is done also to a considerable extent in France. Here again the difficulty is one of *management*, not of speed.

Now, however, I come to the kernel of the whole matter. Why should high speed be employed at all? Why should railways run faster than omnibuses or even than a walking pace? Why should not all merchandise and produce be conveyed along roads or canals? The entire freights of the whole world could be covered by horse-drawn vehicles. It would merely be a case of multiplying horses and vehicles, and then the farmers, too, would thrive through the demand for fodder, etc. Imagine such a suggestion being made to any practical man! Would he not instantly shriek in horror that the world's business could not possibly be carried on under such conditions, because of the inordinate time that would be occupied both in travelling and in carriage of goods, owing to the pace being so slow? Exactly; and there you get the *raison d'être* of railways—their speed. It is because they can convey persons and goods with such swiftness that they have become absolute necessaries of life, and have metamorphosed the entire face of the civilised world—much of the *un*civilised also—in little more than half a century. The one motive power has been—Speed!

Now, I am fully prepared to be answered, "Oh, yes, of course that is true, but it is an over-statement of the case; surely there is so wide a difference between personal travel at 10 miles an hour and goods carriage at 4 miles an hour on the one hand, and modern express speeds on the other, as to render the two things wholly non-comparable?"

Not at all. I admit the extreme difference, but it emphasises the gist of my whole contention, which is that the high-speed question is purely one of degree and not of principle. Let us admit, for the sake

of argument, that high speed may involve large coal-consumption. I will point out one method by which coal consumption, engine repairs, and cost of signalling may be reduced by any railway company to absolutely *nil*. It is merely by ceasing to run any trains at all. Only, then, whence would come the dividends and interest upon capital? But if you admit that you must burn some coal then you concede the main principle, and it becomes only a question of degree: How much coal it pays to burn? Well, then, suppose we run the passenger trains at 10 miles an hour and the goods at 5—would *that* do? I discern a unanimous roar in the negative. Very good, then double those rates—make them 20 and 10? Still an unqualified negative! Passengers would declare they might as well walk or go in a 'bus, and traders would say they must shut up shop, as they could not get their goods in time to be of any use. Then, clearly, we are driven into the corner that we must adopt some higher rates of speed than these, and the only question remaining is *what rate will pay?*

But then we have to form a thoroughly distinct conception of what we mean by "paying." And I take it that if we turn and twist the problem round and round about to ever so great an extent, it will unavoidably resolve itself into the conclusion that there is *no* fixed rate of speed that is in itself an ideal; that the paying rate depends, and must needs always depend, upon the particular circumstances and requirements of each line, and that no hard-and-fast rule can be laid down on the subject that will be applicable to every case. The one rule which is of universal application is that it will pay to run on any line at any speed that attracts or retains or improves profitable traffic. If this should involve augmented consumption of fuel and larger working expenses under other heads, what matter, if the outlay yield a profitable return? Is it conceivable that the Atlantic City Flyers would be timed year by year at their unprecedented booked speed, unless experience had shown that such exceptional speed paid, or had the probable potentiality of paying? I think too highly of American business acumen to doubt for one moment that the Flyers were put on purely as a commercial investment, and I know that this investment has been claimed to be a success. Is it a mere coincidence that the fastest railway in Europe, the Northern of France, pays to its fortunate shareholders dividends of 15 to 17½ per cent., or that the two slowest railways in Britain have drifted into such a ghastly mess that their position and methods are constantly characterised in the public press as "The Great Railway Scandal?" I cannot think so. My experience convinces me that where you find consistently high speed

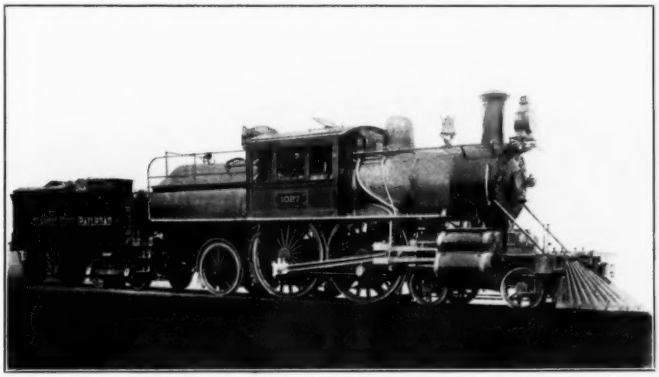
there also you find, as a rule, better permanent-way, better rolling-stock, higher efficiency, and—their concomitants—less proportionate cost of repairs and less liability for compensation on account of delays and accidents due to inefficiency.

But, beyond this, the supreme object of a railway company is to secure profitable traffic. The first merit that makes for this end is conveyance with swiftness. It is often said, very foolishly and thoughtlessly, that punctuality is more important than speed, and that it is preferred by travellers. I have characterised this saying as "foolish," because it sets up an antagonism which has no real existence, and as "thoughtless," because a moment's thought would evoke the suggestion that punctuality is *a priori* more probable when high speed exists with its invariable accompaniments of superior discipline and habitual smartness, than where customary sluggishness in speed has developed a spirit of dilatory indifference. And experience demonstrates that such is actually the case in practice. The slowest railways in Britain are also the most unpunctual—"audaciously unpunctual," as one writer has well put it.

It is unfortunate that the query: "Does high speed attract and retain and improve traffic?" can only be answered on the strength of circumstantial evidence. Nobody can prove absolutely that the improvement in traffic on a railway which has accelerated its services is directly due to such acceleration, any more than the converse could be demonstrated if desired. But undoubtedly there is a large weight of circumstantial evidence in the affirmative. I have been shown official and authoritative statements to the effect that the "Atlantic City Flyers" have given satisfactory results, and this is supported by the fact that the number of the "flyers" has been doubled this season. Also I have been assured, on what I have reason to believe to be good authority, that other accelerations in the United States have been followed by increased traffic. In Britain the accelerations of 1895 were accompanied and followed by a vast development of the Anglo-Scottish traffic. The presentation of such facts as these does, of course, involve the demand for proof that the results are *"propter hoc"* and not merely *"post hoc,"* that they are not the mere natural developments of trade, instead of being due to accelerated transit. I shall not shrink from this problem. It is one with which I am entirely familiar. But as I have already said, I can meet it only with circumstantial evidence, although I can also adduce some very strong *a priori* reasons why such results might be expected to accrue.

Circumstances bring me into communication with a large number

of people who leave London every year in the summer or autumn for a change of air and scene. Formerly they would go to the various seaside places or points of interest in England proper, or would even cross the Channel, but Scotland was to many an unknown land. If asked why they never visited Scotland, they invariably would reply that the distance was so great and the journey so very long and tedious. But since the accelerations of 1895—usually called "The Race to Aberdeen"—there has been an enormous expansion of the Anglo-Scottish traffic. For many weeks during July, August, and September the principal expresses, which have been more than doubled in number, have to be sent off day after day in duplicate and even triplicate, and I have known fourteen heavy expresses despatched on a single evening from one London station to Scotland, instead of the four shown in the time-table. But I may be asked how I know that the accelerations have done this. My answer is that the people who now go and formerly did not, have said to me that they had imagined the journey to be far longer and more tiresome than they found it actually to be, and that the truth was brought under their notice by the "racing" of 1895, and the subsequent acceleration of the regular trains. When they read that trains had reached Aberdeen—"*ultima thule*" in their previous ideas—from London in 8 hours 32 minutes by the West Coast and 8 hours 40 minutes by the East Coast: Perth in 7¼ hours, and Edinburgh 6 hours 19 min., and all this without the slightest hitch or mishap, they realised that neither the distance nor the journey was so very formidable after all. So they tried it, and having once tried it they now go to Scotland year by year, and will

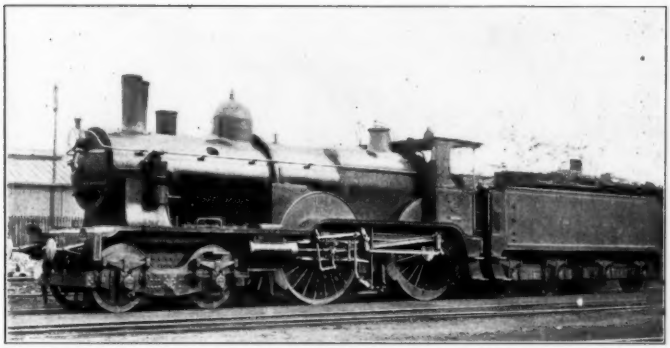


TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUN IN AMERICA – 55½ MILES IN 50 MINUTES ON THE ATLANTIC CITY FLYER

continue to go. Is there any good reason to doubt that the experience of these particular persons who communicated it to me is also that of many others, and that here we have the true explanation of the last quinquennium's traffic developments? I think not. High speed is an excellent advertisement.

Nor is it difficult to see why this should be so. In the case of long-distance journeys, such as those between London and the Scottish Highlands, a saving of several hours of travel in the cramped compartment of the normal British "coach" is manifestly a boon—indeed, often renders the journey possible at all in the case of delicate or sickly people. But there are many other instances in which certain journeys are feasible only when done at a high rate of speed. Take the case of daily trips between a commercial city and a seaside resort. These are only possible to business men on the condition that they do not necessitate an excessive expenditure of time and strength in travelling. Of these circumstances the Atlantic City Flyer is the most brilliant offspring. By making a start-to-stop run of 55½ miles in 50 minutes, the fastest in the world—at the average rate of 66.6 miles an hour—business men can travel between seaside residence and place of business in the even hour, including a ferry crossing. Following this example, the North Eastern Company, of England, have put on special "business expresses" to run between Leeds and Scarborough, 68 miles in 75 minutes, and following still farther behind we have the "London-Cromer special" and the "London-Brighton Pullman Limited," each averaging about 50 miles an hour. This does not compare brilliantly with the Atlantic City's 66.6, still the principle is the same, and it is manifest that this is being grasped, if slowly, by railway companies throughout the world. Time is the one thing whose loss is absolutely irreparable. The modern necessity in all directions is to save this priceless treasure. That can only be effected in travelling by celerity of transit, and while this is largely promoted by length of non-stopping runs, and by smartness of station work, the primary essential is—speed.

It is so, too, with goods traffic. Often the entire difference between profit and loss, between success and failure, depends upon the delivery of goods at a certain time. In all cases early and prompt delivery is of the highest importance. Hence we get the "express goods" and "important express goods" trains which in England are even worked by passenger-express locomotives and take precedence of some passenger trains. Nor is the advantage of rapid goods-transit confined to the consignors and consignees of freight. The railway company



TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUNS IN FRANCE—81¼ MILES IN 81 MINUTES, CHEMIN DE FER DU NORD, AND 67¾ MILES IN 66 MINUTES, CHEMIN DE FER DU MIDI.

itself is a large gainer. By getting goods quickly along the line and therefore quickly off it, twice or thrice as much work can be got off one track as is obtained by the slower method. Consequently some British railways have to lay down four tracks, which even then are overcrowded by the traffic which another line works with ease and freedom on two tracks, merely because in the latter case powerful engines haul enormous trains at fast speeds, and so get the goods soon out of the way and leave the line clear for passenger expresses. The extent to which this is done in America has long been noted with interest in England, but the plan has not been copied for reasons of detail. But in France the practice is growing more and more, and those 50 six-wheel-coupled four-cylinder-compound bogie engines which I described and illustrated in THE ENGINEERING MAGAZINE of Feb., 1899, page 798, were built specially with this object, although they are now coming much into use for heavy passenger expresses. The other leading French lines are adopting a similar course, the object being augmented speed, notably up-hill, in the case of the passenger expresses, which are not allowed to run faster than 75 miles an hour down-hill, and so have to gain their time in the ascent of rising grades.

Thus, looking at the question from its various viewpoints, we obtain the same deduced result—that high speed on railways does pay if judiciously managed; that by attracting, maintaining, facilitating, and improving traffic, it enables railways to fulfil the function which forms their main *raison d'être;* that there is no proof that increased speed involves proportionate increase in coal consumption, excepting

CALEDONIAN RAILWAY ENGINE NO. 767. TYPE OF ENGINE MAKING THE FAST RUNS IN THE ANGLO-SCOTTISH SERVICE.

on rising grades; that with light loads any increase is very small, while such increase as is caused by hauling heavier loads more than recoups itself because it is incurred through increase of traffic, which it is the primary object of all railways to secure and the special function of high speed to induce; and that if the result of acceleration be unfavourable, the fault lies with the management, not with the speed.

I have frankly admitted from the outset that my argument would be, and must be, based on circumstantial evidence and on deductive reasoning, because no statistics exist, or are likely to exist, that constitute any valid proof one way or the other. I have not touched on the question of any danger attaching to high speeds, because all intelligent and well-informed readers will be aware that *there is none*, so far as mere speed is concerned. High speed is only run at risk on unsound or unsuitable roads, and in many cases it has saved a train accident from becoming a terrible catastrophe by enabling the train either to cut through an obstacle which else would have wrecked it, or to skim over a defective road with a minimum of danger, as in the St. Neots and Bytham mishaps on the English Great Northern Railway. In the case of the Preston accident a speed of only 40 or 50 miles an hour was sufficient to cause disaster through being run round a curve of only 154 yards' radius without check rail or proper cant; on another part of the same journey that train had often run with entire safety at 80 to 87 miles an hour under my own personal observation. Thus there is no factor of danger to be taken into account in considering the question, "Does High Speed Pay?" which I unhesitatingly answer in the affirmative.

The accompanying illustrations of the engines which make the fastest start-to-stop runs respectively in Britain, America, and France are reproductions of photographs by Mr. F. Moore, of Charing Cross Road, London.

# GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

*By A. G. Charleton.*

## I.—HISTORY, POSITION AND GENERAL FEATURES OF THE GOLD-FIELDS.

FEW people living at the close of the nineteenth century, who take any interest in mining matters at all, can be unfamiliar with the name of Kalgoorlie—or, as it is sometimes written, Kalgurli (the name of a small hill close to the township); many, however, are at best but imperfectly informed of its remarkable history and surroundings.

A few years ago it was a small, unknown mining camp, in the "back blocks" of the crown colony of Western Australia, with a few canvas huts and shanties of corrugated iron dotted about; to-day, a mining town of the first importance, the name of which will be handed down to posterity as a landmark of British colonial enterprise, and as one of the most active centres of the mining industry. A tribute must be paid to its phenomenally rapid development, galvanized into industrial life, as it has been, by the confidence of the capitalist and the energy of the miner, of which I believe we see but the commencement.

A new gold-mining discovery always excites a broad general interest, because it offers a wide field alike for the profitable employment of labour and of such surplus capital as may be legitimately employed by people with means enough to embark money in mining. The allurement lies in the prospects it offers, if used with judgment, of a rapid accumulation of wealth, which the habitual investor in consols or gilt-edged securities neither requires nor is ever likely to realise. But beyond this, Hannan's (as Kalgoorlie is sometimes called), possesses a

Australia is interesting from a mining point of view on account of the lateness of its appearance among gold-producing regions, of its dramatic leap into prominence, and of its peculiar climatic conditions imposing special problems. Mr. Charleton's paper in this issue is the first of a series which will deal with topographical, climatic, and geological features of the field, the engineering practice developed to meet the local requirements, and the methods and equipment of the largest and most characteristic Australian properties.—THE EDITORS.

special interest for engineers, owing to the unique character of its surroundings and to its telluride deposits, which have entailed modifications of ordinary practice in developing and working them, and brought to light various new and interesting facts, from a geological, engineering, and metallurgical point of view. The circumstance that capital has doubtless been wrecked on its "reefs" by crazy speculators is not, generally speaking, the fault of the field, the geologist, or the miner; it is attributable chiefly to "market influences," coupled with neglect of the ordinary precautions which control the operations of prudent business men, as distinguished from the unwary mining speculator, who comes to grief through ignorance of the first principles of all successful business, for want of a well-organised intelligence department.

The object of this article is to present a sketch of the conditions under which mining has been and is being carried on at Coolgardie and Kalgoorlie, the two premier gold fields of the colony. The material is drawn partly from personal experience, partly from papers published by various societies, and journals not generally available for reference, and partly from notes supplied most kindly by various professional friends and mining companies, from the published annual reports of mines, and from government publications.

It was not till long after William Dampier landed on the west coast of Australia, in 1688, in company with the mutineers of the Cygnet, that gold mining sprang actually into existence, though he is credited on his return from England in the Roebuck, a year or two later, with the discovery of gold on the northwest seaboard, which is marked on old Dutch or Portuguese maps *Provincia Aurifera.* Later on, in 1847, Mr. John Calvert, visiting Exmouth Gulf in the Scout, again drew attention to the fact that the district was gold-bearing, bringing back with his specimens, on the strength of which he endeavoured to form a company in 1849, but failed to do so.

Proof of the existence of gold in paying quantity dates back, however, only to 1886, following upon the issue in 1884 of a map by Mr. E. T. Hardman, then government geologist, showing places where gold was likely to be found; this was after his return from a prospecting expedition to the Kimberley district, in 1882-1883. The Kimberley field was subsequently proclaimed in May, 1886, when the first "rush" took place; whilst Yilgarn was next discovered by Anstey in 1884; but it was not till May or June of 1892 that Bayley and Ford, starting from Southern Cross, set out on their eventful expedition, which resulted in the discovery of the Coolgardie gold field, where

they secured some 2,000 ounces of gold by "dollying."* This last discovery imparted an impetus to prospecting further afield, and Kalgoorlie was located by Patrick Hannan's party in June, 1893—an historical event which has proved probably as important to Western Australia as Marshall's discovery of gold in 1848, at Sutter Creek, was to California.

There are now seventeen recognised gold-fields in Western Australia, viz.: (1) Kimberley; (2) Pilbarra; (3) West Pilbarra; (4) Ashburton; (5) Gascoyne; (6) Peak Hill; (7) Murchison; (8) East Murchison; (9) Mt. Margaret; (10) Yalgoo; (11) North Coolgardie; (12) Yilgarn; (13) Coolgardie; (14) Broad Arrow; (15) East Coolgardie (better known as Kalgoorlie); (16) North-East Coolgardie; (17) Dundas. Their general position is shown on the accompanying map. I need only add that they are divided into sub-districts, being dotted with various independent mining camps.

The discovery of these gold-fields was in some instances not altogether without romance, notwithstanding their prosaic surroundings, perhaps in no case more so than in that of West Pilbarra, of which I may quote the story as commonly told. It appears that a discerning youth of tender years picked up a stone to throw at a cow (some say a crow), and noticing that it contained gold, reported the fact to the "Warden." This gentleman was so excited at the news that he flashed the intelligence by wire to the then Governor of the Colony, informing him that a lad had picked up a stone, to throw at a crow—but forgetting to add that he had seen gold in it! The Governor, much surprised, but moved by curiosity, wired back: "Yes; and what happened to the crow?" (or cow). This elicited explanations which led to the proclamation of the district as a gold-field, and in consequence of the rush that followed in the same year (1888) 3,493 ounces of gold were obtained, valued at £13,273, early attention being drawn to the district by the discovery of several large nuggets, one of which weighed 140 ounces.

The North-East Coolgardie field, to which this and subsequent articles will be devoted, covering as it does only 632 square miles, is with one exception the smallest of the above-named seventeen gold-fields, which possess a total area of 324,569 square miles, proclaimed

* John Ford made the first discovery of gold, near the Coolgardie water hole, picking up a piece weighing about half-an-ounce lying on the surface at a spot afterwards known as "Fly Flat." Messrs. H. M. Lefroy, in 1863, C. C. Hunt in 1864, J. Forrest in 1871, E. Giles in 1875, and D. Lindsay in 1891, who had previously visited the district, seem to have been unaware of its auriferous character, though Hunt discovered some outcrops of quartz near Hampton Plains.

as "open for location." Nevertheless, it has the enviable distinction of a larger output of the precious metals than all the other fields combined, hence its importance. Up to December, 1899, Hannan's, in fact, is credited with an output of 1,819,021 ounces of gold, produced in less than 5½ years. The output of the whole of Westralia (Kalgoorlie of course included,) from 1886 to the end of December, 1899, is placed at 4,336,679 ounces, 8 pennyweights, 4 grains, which, calculated as having an average value of £3 16s. per ounce, represents £16,479,383 8s. 6d.

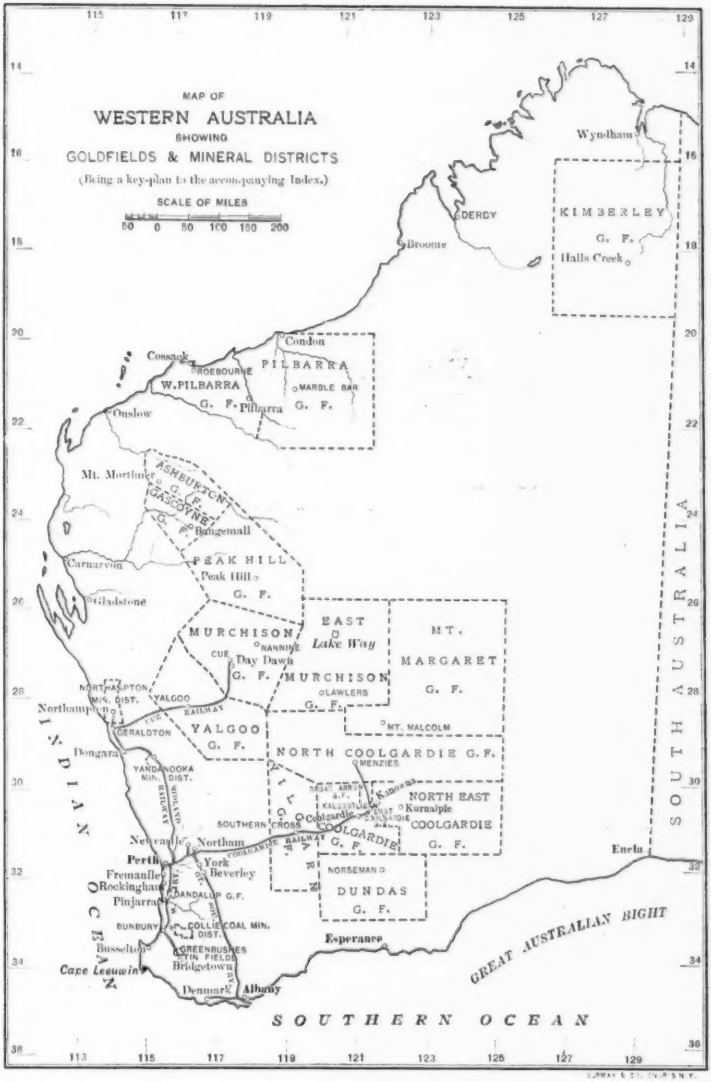
The colony of Western Australia, which comprises all that part of the Australian Continent west of the 129th meridian, has an aggregate area of 975,920 square miles, half of which is within the tropics, and whilst the interior is dry and hot and subject to very sudden changes, the coast is warm, with a rainfall varying from 20 to as much as 42 inches at the Canning waterworks in the Darling Ranges. The census in 1895 gave Western Australia a population of 101,235, but it must since have grown much larger, being estimated at 170,000 in 1898. The revenue for the six months ending June 30, 1899, was £1,278,139, against which is set an expenditure of £1,201,341.

The dividends paid or declared by British-owned Western-Australian mining companies for three years are officially given as: 1897, £475,150; 1898, £770,829; 1899, £2,168,556, showing a rapid and gratifying increase. Total, £3,414,535. The port of Freemantle is distant only about 12 miles from Perth (the capital of the colony) but up to 1898 all mails and passengers for the gold fields were landed at Albany on St. George's Sound, which is connected with Perth by railroad,* the distance between the two places being 338 miles.

Kalgoorlie lies east (slightly north) of Perth, 315 miles from Spencer's Brook, a junction on the Perth-Albany line, 58 miles east of Perth, the distance by rail to Kalgoorlie from Perth thus being 373 miles, and from Albany 594 miles. The time taken by express in one case is about 18½ hours, in the other 27 hours, if, as possibly sometimes happens, the trains run up to time.

The North-East Coolgardie gold-field is, however, within 200 miles of a port on the coast, at Esperance Bay, with which it must inevitably be ultimately connected by rail; once the powerful interests opposed to the construction of an outlet on the south coast can be overcome, it must cheapen and facilitate communication with the

* The gauge of the West Australian railways is 3 feet 6 inches, and they are mostly single lines, the rails weighing 46¼ pounds per linear yard. The cost of construction has varied from £3,600 on the Midland to £5,088 on the Government lines.


MAP OF
WESTERN AUSTRALIA
SHOWING
GOLDFIELDS & MINERAL DISTRICTS
(Being a key-plan to the accompanying Index.)
SCALE OF MILES
50 0 50 100 150 200
Wyndham
KIMBERLEY
G. F.
Halls Creek
DERBY
Broome
Condon
PILBARRA
MARBLE BAR
G. F.
Cossack
ROEBOURNE
W. PILBARRA
G. F.
Pilbarra
Onslow
Mt. Mortimer
ASHBURTON
GASCOYNE
G. F.
Bangemall
Carnarvon
PEAK HILL
Peak Hill
G. F.
Philadstone
MURCHISON
NANNINE
Day Dawn
G. F.
EAST
Lake Way
MURCHISON
LAWLERS
G. F.
MT.
MARGARET
G. F.
NORTHAMPTON
MIN. DIST.
YALGOO
Northampton
GERALDTON
YALGOO
G. F.
MT. MALCOLM
NORTH COOLGARDIE G. F.
MENZIES
Dongara
YANDANOOKA
MIN. DIST.
NORTH EAST
COOLGARDIE
G. F.
Kurnalpie
SOUTHERN CROSS
Coolgardie
KALGOORLIE
COOLGARDIE
G. F.
Newcastle
Northam
Perth
Fremantle
Rockingham
Pinjarra
York
Beverley
DANDALUP G. F.
BUNBURY
COLLIE COAL MIN. DIST.
GREENBUSHES
TIN FIELD
Busselton
Bridgetown
Cape Leeuwin
Denmark
Albany
NORSEMAN
DUNDAS
G. F.
Esperance
Eucla
INDIAN OCEAN
GREAT AUSTRALIAN BIGHT
SOUTHERN OCEAN
SOUTH AUSTRALIA

LAKE LAPAGE.

field, benefiting at the same time Dundas and the districts in the south of the colony.

The line from Perth gradually climbs the Darling range from the coast, a rise of about 1,000 feet, till it reaches the table-land of the interior—Spencer's Brook being 520 feet above sea level—from which point the line rises gradually until it reaches an elevation of 1,240 feet at Kalgoorlie.

This area forms a plateau, presenting a succession of ridges which have a gradual north-and-south direction, undulating like the surface of the ocean after a gale. Their crests, which are separated from one another by shallow valleys varying in width from a mile or less to ten miles or more, frequently consist of domes of granite, laid bare and polished by the wind-driven sand, whilst here and there an iron-stone "blow" breaks the monotony of the surroundings by its greater irregularity.

The "lake-beds," coloured blue on maps, are shallow basins with clay bottoms, dry as a rule, though perhaps containing an occasional pool of brine, or brackish water, which lingers there after the rainy season, giving rise to a so called "soak," where water has accumulated in a depression and is obtained by digging through the covering of sand. The streams, which really run only for a brief period after heavy rains, are really sandy channels sculptured out by the drainage

system of the country, marking what may once have been the course of ancient rivers, of which a mere trace remains unobliterated by denudation.

Taking a line from Lake Darlôt to Dundas (which would average about 1,400 feet above the sea) as the axis of the plateau, for 50 miles on either side there is but slight variation in altitude, and the general character of the country is everywhere very uniform. The land falls away from this central dome eastward, until the younger horizontally-bedded rocks of the Great Victoria Desert are reached, and to the west and south, to the Indian and Southern Oceans. The general impression is that of an endless plain with gentle undulations, the depressions of which are filled with the products of erosion.

In the interior the miner is dependent for all his supplies of natural drinking water on an occasional well, "clay-pans," and the rock-enclosed "water-holes," which are found in hollows exclusively in the granite. In the absence of well-defined water courses, the rain water is largely absorbed by the porous sandy soil, except after heavy storms, when large tracts are covered by sheets of water which gradually soak away or drain down to one of the aforesaid "lakes."

The rock formation of this plateau consists mostly of granite, pierced by igneous intrusions of diorite and kindred plutonic and volcanic rocks—porphyry and andesites, associated, it is said, in places with tuffs, which Mr. T. A. Rickard states have in some instances been mistaken for sedimentaries. He remarks, "There are no fossil-bear-

AN AUSTRALIAN WATER HOLE.

ing rocks, such as would afford a datum-line from which to measure the relative geological age of the prevailing formation. The age of the rocks of the Coolgardie area can only therefore vaguely be described as Archæan." *

Notwithstanding, however, some of the natural drawbacks I have referred to, Western Australia is not by any means such a bad place to live in as many other parts of the world, as it possesses several inestimable advantages—rich gold-fields, a progressive Anglo-Saxon population, handsome towns, and a climate which, if not entirely free from dust, is at any rate healthy, if proper sanitary precautions are taken.

The dust-storms, which rage for days at a time, are certainly a nuisance, but a secondary source of annoyance compared with the bush-flies,† which give rise to the common complaint of "bungeye," a painful swelling of the eyelids. Scorpions, centipedes, snakes, and

THE DEVIL'S ARCH, NIAGARA.

"red-spiders" are more often heard of than seen, and the smaller forms of irritating insect life are those that are most to be dreaded. The rainfall varies considerably; thus, while at Kalgoorlie it only amounted to 2¾ inches in 1894 (an exceptionally dry year), in 1893 it came to 4¾

* The Alluvial Deposits of Western Australia, by T. A. Rickard, A. R. S. M., Trans. Am. Inst. Mining Engs., Oct., 1898.

† It is said that Bayard's eucalyptus oil, distilled from eucalyptus maculata (var. citrodora) will keep off flies and mosquitoes.

inches, but scarcely ever exceeds 8 inches. The average is probably between 4 inches and 7 inches. That the climate has not always been so dry, however, is evidenced (as Mr. E. S. Simpson, the government mineralogist, points out), by the discovery near Coolgardie (which is about 24 miles from Kalgoorlie), of a thick bed of brown coal containing numerous fossil fern-leaves.

ON THE BULONG ROAD.

The local meteorological conditions at two places as close even as Coolgardie and Kalgoorlie—the latter town being situated in latitude 30° 45′ south, and longitude 121° 30′ east—are by no means identical. In striking contrast to the rainfall, the rate of evaporation is estimated as equivalent to 7 feet per annum.

It must not be supposed, however, as might be expected under such climatic conditions, that the general aspect of the country is that of a South African desert. Far from it, as nearly the whole plateau is covered with low "scrub" and "bush," in which the ti-tree and mulga (species of flowering acacias), salmon-gum (eucalyptus salamonophlia), and gimlet-wood predominate.* This bush remains green all the year round, individual trees attaining a height of 20 to 80 feet, and 3 inches to 3 feet in girth. Here and there may be noticed a patch of "nigger-head," a dwarf palm, crowned with a cluster of leaves like the head-dress of a South-Sea islander, as well as other curious tree-shrubs, such as the sandal wood, which flourishes in the sandy interior.

METEOROLOGICAL CONDITIONS AT COOLGARDIE, 1897.

| Month | Temperature | | | | | Temperature of Dew Point. Mean | | Rainfall | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean Max. ° | Mean Min. ° | Highest Min. ° | Lowest Max. ° | Greatest Variation in one day ° | 9 A. M ° | 3 P. M ° | Total inches | Days |
| January ..... | 94.1 | 63.2 | 104.3 | 53.0 | 42.2 | 53.5 | 54.0 | .56 | 4 |
| February ..... | 89.4 | 58.5 | 104.6 | 47.4 | 47.3 | 51.8 | 53.6 | .54 | 5 |
| March ..... | 85.6 | 57.7 | 98.4 | 50.0 | 41.0 | 49.2 | 55.0 | .10 | 2 |
| April ..... | 81.2 | 53.9 | 96.1 | 39.1 | 36.5 | 51.3 | 57.4 | .01 | 1 |
| May ..... | 71.4 | 46.6 | 88.4 | 38.2 | 41.5 | 46.9 | 53.5 | .09 | 3 |
| June ..... | 62.9 | 43.9 | 71.2 | 31.5 | 29.8 | 44.2 | 49.7 | 1.04 | 9 |
| July ..... | 65.1 | 42.4 | 74.0 | 36.5 | 33.5 | 43.5 | 47.5 | .34 | 6 |
| August ..... | 63.8 | 41.5 | 81.0 | 33.0 | 34.6 | 40.8 | 43.7 | 1.08 | 10 |
| September ..... | 75.0 | 47.5 | 92.0 | 35.0 | 39.7 | 43.7 | 49.5 | .29 | 6 |
| October ..... | 81.0 | 49.8 | 91.0 | 41.0 | 39.7 | ... | ... | .06 | 2 |
| November ..... | 90.6 | 58.4 | 105.0 | 47.3 | 44.6 | ... | ... | .09 | 1 |
| December ..... | 91.7 | 59.5 | 109.2 | 51.0 | 44.2 | ... | ... | 1.31 | 4 |
| | | | 1898. | | | | | | |
| January ..... | 97.6 | 65.1 | 111.2 | 54.0 | 43.2 | 60.1 | 68.2 | nil. | .. |
| February ..... | 89.3 | 62.5 | 107.2 | 48.0 | 37.7 | 57.0 | 60.2 | .27 | 1 |

METEOROLOGICAL CONDITIONS AT KALGOORLIE, 1897.

| Month | Temperature | | | | | Temperature of Dew Point. Mean | | Rainfall | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean Max. ° | Mean Min. ° | Highest Max. ° | Lowest Min. ° | Greatest Variation in one day ° | 9 A. M. ° | 3 P. M. ° | Total inches | Days |
| January ..... | 92.9 | 66.0 | 105.0 | 55.0 | 34.2 | 51.1 | 52.0 | .38 | 2 |
| February ..... | 88.2 | 61.6 | 103.0 | 49.0 | 34.7 | 51.2 | 51.5 | .02 | 1 |
| March ..... | 83.8 | 58.9 | 98.4 | 51.0 | 39.0 | 49.0 | 49.4 | .52 | 6 |
| April ..... | 80.0 | 55.9 | 95.4 | 38.8 | 32.8 | 48.0 | 46.8 | .20 | 1 |
| May ..... | 69.8 | 48.0 | 88.1 | 37.0 | 40.4 | 46.5 | 45.0 | .10 | 1 |
| June ..... | 62.9 | 47.4 | 73.2 | 36.2 | 30.2 | 46.4 | 49.1 | 1.26 | 14 |
| July ..... | 64.4 | 43.3 | 74.0 | 33.2 | 29.8 | 42.8 | 43.7 | .22 | 3 |
| August ..... | 63.8 | 43.3 | 82.0 | 34.0 | 29.1 | 40.0 | 41.7 | .65 | 9 |
| September ..... | 74.2 | 48.8 | 90.8 | 37.2 | 40.2 | 41.6 | 43.8 | .41 | 5 |
| October ..... | 78.5 | 51.8 | 90.2 | 41.0 | 38.0 | 42.0 | 40.4 | .11 | 2 |
| November ..... | 90.2 | 59.0 | 103.0 | 48.0 | 49.0 | 46.8 | 48.7 | .06 | 1 |
| December ..... | 90.7 | 61.6 | 109.2 | 49.4 | 39.0 | 48.3 | 49.5 | .82 | 4 |
| | | | 1898. | | | | | | |
| January ..... | 98.0 | 66.8 | 113.2 | 55.0 | 41.0 | 51.3 | 50.3 | .02 | 1 |
| February ..... | 90.5 | 63.4 | 109.8 | 48.2 | 38.6 | 51.2 | 49.9 | .36 | 3 |

TABLE OF TEMPERATURE, RAINFALL, HUMIDITY, ETC., COOLGARDIE AND KALGOORLIE, 1897.

To the pedestrian compelled to "hump his swag" * the tracks or roads, cut through the "bush" with the conventional straightness of a Roman highway, are inexpressibly monotonous, and when an elevated point is reached, the eye sweeps over miles and miles of dull green forest, the only evidence of human surroundings, perhaps, a wisp of blue smoke from some distant campfire, or a deserted "mi-mi," † lately tenanted.

Many of the trees, however, shed their bark annually, when the new wood exhibits delicate tints of red, pink, salmon, and green, which affords a little variety. The thin, lanceolate, grayish leaves, which at times look as if varnished, give but little shade. The quandong and kroorajong, which grow in isolated spots, are said, however, to afford some protection from the blazing sun.‡ The view in these forests extends for a few hundred yards only, and grass is frequently absent, or only to be found in scattered tufts—sand, boulders, or bare rock lying all around. In spring the forest land in places is, however, abundantly carpeted with brilliantly coloured flowers of the "everlasting" species, belonging to the genera Helichrysum, Helipterum, Waitzia, Podolepis, and Angianthus—"magnificent splashes of colour carpeting the desert with splendour,"§ but wholly devoid of perfume, and with the dry, brittle texture of immortelles.

An old man kangaroo, or wallaby, bounding off like a boy in a sack-race, a mob of cattle grazing on a "station," a troop of noisy parroquets, the flight of a leisurely circling kite, or a laughing-jackass perched on a gum-tree, occasionally break the pervading solitude; otherwise the bush is a wilderness, seemingly devoid of life except when invaded by man.

The high elevation of Kalgoorlie, and its latitude (more than 30° south), no doubt account for the coolness of the winter months (July, August and September), when, as a rule, an overcoat can be worn with comfort except at midday. Even in summer, there is a cool crispness of the air at night, though the shade temperature during December, January, and February is often very high. During a visit I paid to the field in 1898 the thermometer registered one day, January 9, as much as 113.5° F. in the Palace Hotel.

Typhoid fever and dysentery are the worst scourges in the towns,

* Carrying all his worldly goods on his back.

† A bush hut formed of four posts roofed with eucalyptus boughs with the leaves on.

‡ The valuable forests of jarrah (eucalyptus marginata)—which often attains a height of 100 feet with a diameter of 3 to 5 feet and is most useful for piles, wood-paving, etc., owing to its hardness and durability in water—are found in the southwest division of the colony, as also karri (eucalyptus diversicolor) which sometimes reaches a height of 250 feet.

§ T. A. Rickard, ibid.

A WILLY WILLY, OR REVOLVING DUST STORM

being more or less prevalent in the hot season, owing partly to the failure of sanitary arrangements to keep pace with the growth of population, to impure drinking-water, to the germs carried by dust,* and to personal carelessness of hygienic precautions; people leading sedentary lives, like bank-clerks, appear to suffer most.

In a climate of this description, the agencies of surface-erosion work for destruction as slowly but surely as the levelling action of socialism. The absence of ordinary evidence of water erosion, alternating drifts of sand and stretches of bare rock, bear testimony to the important part the wind has played (without counting the familiar

* In South Africa, dust is considered to be one of the chief causes of dysentery. The same is no doubt the case in West Australia.

trumpet of the company promoter), in the history of the West Australian gold fields. It has helped to carry the products of denudation, and liberated a great portion of their contained gold close to the spot from which it was originally derived—close, in comparison with what would have happened had the transporting agent been water. Wind, though usually an insignificant factor in its geological effects, has in this instance, as will be seen hereafter, played an important function, not only in the formation of local deposits of alluvial, but also in enriching the upper decomposed portions of the Kalgoorlie formations, its action doubtless extending over æons of time to produce these remarkable results. The effects produced by the constant wearing action of sand are shown by pieces of glass lying on the surface, which are invariably so scratched as to have a frosted appearance.

The violent dust storms, driven in gyrating columns or charging clouds across the surface of the "flats" and along the streets of Kalgoolie, set in motion by the draughts that obtain on this elevated plateau, are an extraordinary sight, and show the amount of material that can be moved in this manner. The whirlwinds, veritable wind-spouts, termed by the aborigines "willy-willies," springing up suddenly, spin madly along, sometimes straight ahead, sometimes in circles, collecting the dust, sand, paper, and refuse they find in their track and sucking up all the loose objects they come across, move rustling and hissing along until, subsiding as suddenly and erratically as they arose, they deposit their burden of material, which weathering and erosion has disintegrated, far from its original cradle. As will be seen from the accompanying photograph, the "willy-willy," though more impressive, is perhaps less potent in its effects as a conveyor than the steadier and more continuous dust storms travelling straight along in one direction, and its action is chiefly disintegrating.

To illustrate the power of the wind—termed by geologists "æolian agency"—Mr. T. A. Rickard has pointed out that elsewhere in Australia fences more than four feet in height have been known to be buried in a little more than two years, while in Egypt sand storms bury the temple of the Sphinx every summer, and the road built by Ismail Pasha from the Mena House to the Pryamids is filled up with sand to the level of the six-foot parapet in less than 10 days!

But wind has done something more than merely disintegrate and transport the loose material lying on the surface; it has likewise "winnowed," and so *classified*, it. This is impressed on the observer travelling through the country, by acres and acres strewn with a sheet of angular fragments of white or coloured quartz, while close by patches of

WIND FORCE, 1897.

| Month | Coolgardie 9 A. M. Max. | Coolgardie 9 A. M. Min. | Coolgardie 3 P. M. Max. | Coolgardie 3 P. M. Min. | Kalgoorlie 9 A. M. Max. | Kalgoorlie 9 A. M. Min. | Kalgoorlie 3 P. M. Max. | Kalgoorlie 3 P. M. Min. |
|---|---|---|---|---|---|---|---|---|
| January | 3 | 1 | 3 | 0 | 2 | 1 | 3 | 3 |
| February | 4 | 2 | 4 | 1 | 7 | 2 | 7 | 2 |
| March | 3 | 2 | 3 | 1 | 5 | 2 | 2 | 0 |
| April | 4 | 0 | 3 | 2 | 2 | 1 | 9 | 1 |
| May | 8 | 2 | 3 | 0 | 5 | 2 | 2 | 2 |
| June | 2 | 1 | 3 | 2 | 9 | 2 | 5 | 2 |
| July | 5 | 1 | 6 | 1 | 3 | 2 | 4 | 2 |
| August | 5 | 1 | 6 | 1 | 6 | 2 | 8 | 2 |
| September | 9 | 1 | 9 | 1 | 6 | 2 | 9 | 2 |
| October | 5 | 1 | 8 | 1 | 7 | 2 | 6 | 2 |
| November | 6 | 1 | 9 | 1 | 5 | 2 | 8 | 2 |
| December | 9 | 1 | 4 | 1 | 2 | 2 | 3 | 2 |

Beaufort's scale of wind force is as follows:

| Number | Description | Speed of Wind in Miles per Hour. |
|---|---|---|
| 0 | Calm. | 3 |
| 1 | Light air. | 8 |
| 2 | Light breeze. | 13 |
| 3 | Gentle breeze. | 18 |
| 4 | Moderate breeze. | 23 |
| 5 | Fresh breeze. | 28 |
| 6 | Strong breeze. | 34 |
| 7 | Moderate gale. | 40 |
| 8 | Fresh gale. | 48 |
| 9 | Strong gale. | 56 |
| 10 | Whole gale. | 65 |
| 11 | Storm. | 75 |
| 12 | Hurricane. | 90 |

VARIATIONS IN DIRECTION OF THE WIND AT KALGOORLIE DURING SEPTEMBER, 1897.

| 9 A. M. Direction of Wind. | 9 A. M. Days. | 3 P. M. Direction of Wind. | 3 P. M. Day. |
|---|---|---|---|
| North | 4 | North | 4 |
| North to east | 5 | North to east | 4 |
| East | 3 | East | 1 |
| South to east | 5 | South to east | 3 |
| South | 1 | South | 4 |
| South to west | 6 | South to west | 7 |
| West | 1 | West | 5 |
| North to west | 2 | North to west | 2 |

TABLE OF WIND FORCE AND DIRECTION, COOLGARDIE AND KALGOORLIE, 1897.

"black sand," glittering a steel gray in the bright sunlight, or blue-black when in the shade of a passing cloud, graduate off into beds of gravel and dust, in which one may wade up to one's ankles. The heavier magnetic or titaniferous iron-sand, the product of the decomposed diorite found close to the spot where it lies, though crumbled to powder, is scarcely affected by the wind which has collected and moved the quartz, detached from the stringers traversing the underlying rocks.

From the extent of the patches of iron-stone and quartz, collected in this manner, one might infer the probable existence of large masses of both near by, but the following extract which I may quote from Mr. Rickard's excellent paper shows that this is by no means always the case: "Owing to the extreme slowness with which denudation progresses in this arid region, and the consequent very gradual lowering of the zone of oxidation, the rocks exhibit above the drainage level a marked intensity of chemical action. The granite is kaolinized to an almost incoherent clay, and the diorite is rendered abnormally heavy in iron by the surface-concentration of decomposition products. And, as the rock is eroded, the quartz, on account of its hardness, persists, so that a series of small stringers eventually yields an accumulation suggestive of its derivation from a large mass." This, no doubt, partly accounts for many mistaken statements and disappointed hopes, to be found in prospectuses, where the prospector has not satisfied himself with more than a mere examination of the surface.

The foregoing process of concentration is not, however, confined merely to the accumulation and enrichment of detrital deposits; there is ground for believing it has affected the enrichment of the upper portions of the formations regarded as lodes in place, since gold particles, scoured off by surface erosion, have no doubt found their way down through minute fissures and seams in the dry kaolinised rock to considerable depths, and gold in solution has doubtless enriched the deposit still further from the surface.

In sampling long cross-cuts through the country rock, in several Kalgoorlie leases, Mr. H. C. Hoover mentions,* as confirming this conclusion, that "few assays were secured above the 100-foot level, which did not yield from a trace to 8 pennyweights of gold per ton. Yet in sampling cross-cuts at greater depths, traces of gold became smaller and smaller, until below the zone of kaolinisation, any trace of gold at all in the country-rock is rare."

* The Superficial Alteration of Western Australia Ore Deposits, Trans. Am. Inst. of Mining Engs., Oct., 1898.

In the Crœsus South United, for example, a cross-cut on the 100-foot level averaged 6 pennyweights per ton, no assay yielding over 10 pennyweights; yet a cross-cut immediately beneath, on the 200-foot level, averaged but 1 pennyweight 11 grains.

The government meteorological reports do not seem to indicate that the wind at Kalgoorlie blows steadily in any one prevalent direction, though Mr. Rickard states that his own observations would have led him to think that it followed as a rule a south-east north-west course, which corresponds with what I myself noticed; that is to say, from the Boulder township towards the Kalgoorlie. The difference in temperature between day and night in Western Australia has also helped in moulding its physiographical outlines, through the action of dew, which, like water, changing in volume with change of temperature, however minute the change may be, brings to bear on the rocks an enormous disintegrating effect, corresponding to the action of frost in colder climates, only on a lesser scale.

In the case of water, the point where detritus settles is governed by the size of the particles, the depth of the current, the slope, size, and course of the channel, as well as by nature of the bed over which it is moved. In the case of air, movement is restricted to shorter distances, and the sorting process produces a deposit of far less regular structure.

Where an outcrop of gold-bearing quartz follows the crest of a ridge, a thin covering of sandy soil will generally be found on its lee side, which thickens perhaps lower down to several feet. A section of such a deposit frequently shows on top a few inches of dust and sand, passing into compacted fragments of stone and quartz, bound together with stiff clay, forming an "agglomerate," locally known as "cement" —"an unclassified product of erosion" (as Mr. Rickard describes it). "lying close to the place of its origin, as a mere collection of unassorted débris."

The underlying rock is so softened by decomposition that it may be, and often is, taken for part of the deposit superposed on it, and if a shaft is sunk, it will penetrate often through feet and feet of this oxidised ground, till solid diorite or granite makes its appearance at a depth of from 50 to 200 feet, where water-level is reached.

My next article will deal with the geology of the Coolgardie goldfield and the method of working alluvial deposits in West Australia, known as "dry blowing."

# THE APPLICATION OF PIECE WORK AND THE PREMIUM PLAN.

*Communicated by Sir Benjamin C. Browne.*

THE great importance of the satisfactory working of some system which will reward the workers for their skill or attention to their work, and thus encourage them to execute their work at the greatest possible speed, has long been apparent to the managers of engineering works.

Apart from the financial gain of an increased output, often at a less cost for labour, which should be the result of a piece-price or premium system, there is a certain, if more distant, gain in the superior class of workman which is produced. That the power of making higher wages by increased skill will gradually produce more and more skilled workmen none will doubt. But there are many cases in which, by short-sightedness or bad management on the part of the employers, more harm than good is done by substituting piece for time work. It is to the reason for some of these failures that I wish to draw attention in this article.

It seems hardly necessary to describe the principles of the piece-price or premium system, but in case there should be a few to whom these matters are more or less strange, it may be well to give a sketch of the best known of these systems.

First, then, there is the piece-work system which is most commonly used in English manufactories, by which the employees are paid so much for each piece on which they perform a certain operation. Some employers using this system pay a slightly increased price when the output from a machine rises above a certain number in a given time, as an extra spur to push the output, but this is not a common practice.

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The accompanying article, while it has had the benefit of Sir Benjamin Browne's supervision and endorsement, is not his own production. It is based on a paper written confidentially for the British Government, by one of the first authorities on the subject in Great Britain, in connection with the work and reorganisation of the most important mechanical departments conducted under Government auspices.

The strictly confidential portions have of course been taken out, leaving a valuable summary of the whole question which is particularly interesting on account of the somewhat vague ideas generally prevailing as to the actual status of piece work in the English engineering industries.—THE EDITORS.

Secondly, there is the premium plan, about which so many able articles have been written lately. By this system the employees are paid never less than their time wages. Should they, however, do their work in less than a given time, they receive, as a premium, payment for some proportion of the difference between the time in which they did the work and the time given them for the work. Thus suppose a man working fifty-four hours a week performs an operation, for which the time given is nine hours, in six hours; he would at the end of the week receive payment for fifty-four hours' work plus a certain proportion of twenty-seven hours, he having saved three hours a piece on nine articles. The merit of this system, from the employees' point of view, is that if they are given a time to perform an operation which they consider too small, they can work at an ordinary time rate without loss to themselves. Looked at from the employers' side, it is seen that if work is done under the given time they receive not only the profit from the increased output of the machines, but also pay a smaller price for each piece.

A variation of the above method is the following: Suppose an engine is to be built to fill an order. An estimate is made of the total number of working hours required to complete it. When the engine is finished, the actual number of hours worked is subtracted from the estimated time, and some proportion of the difference—if the actual time is less than the estimated time—is divided amongst the men who worked on the engine, in proportion to the length of time they worked, and they receive pay for this time according to their rating. The advantage claimed for this system is that every man will try to make the other work as hard as, if not harder than, himself, it being greatly to each man's interest to prevent any slackness on the part of the others.

There are many other variations of the premium plan, and also of the piece-price system, but it is not necessary to discuss the variations in this article.

I think it is important to divide the working of the systems into two parts. The one, where the machines being worked are of the semi-automatic type, such as the modern form of capstan and turret lathe; and the other where the machines are of the ordinary lathe, or boring-machine, etc., type. In the first there is but little skill required by the operator. The tools should be set by skilled workmen, the machine being worked by unskilled hands at a low rate of pay.

The machine man's work consists in little more than pulling or pushing certain handles and fixing the work in the machine. So perfect are these machines now that the man should not require to use

any gauges on his work, it being quite sufficient for an experienced gauger to visit the machine every now and then to see that the tools have not worn too much. There would seem little difficulty in fixing fair prices for such a class of work. The time taken to do each operation can be easily found by watching a machine, if the operation be a short one, and judging if the man is doing his portion of the work as quickly as possible; or, in the case of a long operation, by calculation based on the feeds and speeds which can be worked by the machine on the piece of work in question.

Unfortunately the machines are not always kept up to their best working conditions. The foreman, or manager, allows them to get into a poor state of repair. He does not take the trouble to design really satisfactory tools for dealing with the work. The result is, the machines do not turn out such perfect work; the men require gauges, and file or scrape the work to fit the gauges. It becomes then a far more difficult matter to fix a fair price for the work; it degenerates into a kind of lottery. A man may get an easy piece, or a very hard one. Another evil is apt to creep in, a very bad habit which has long been in vogue in some districts, of settling a piece price in this way. A workman is allowed to make a certain number of articles on time, and then the foreman arranges such a price as will allow him to earn time and a half, *i. e.*, if a man's wages are 6 shillings a day, and he makes one article working quietly, the foreman would give him 6 shillings an article and expect him to make one and a half a day on piece work, and so earn 9 shillings. This makes it to the man's interest to dawdle as much as possible over the trial articles, and also records the fact that at ordinary work a man is not to be expected to work to more than two-thirds of his best efforts. Bad enough in the case of hand work, but intolerable in the case of machine work.

But worse is to follow. It is then common for the clerks to watch the men's earnings, and if they find a man earns more in the week than time and a half, they therefore reduce his piece price. Obviously, therefore, the men take care not to turn out more work than will give them time and a half, and if they find means of doing work more quickly, they will only adopt it so far as it saves them trouble, and in no case will they utilise it to increase the quantity.

Very different from this is the practice in some American shops of paying a man an absolutely higher rate, if he turns out an excessive quantity, on the excess. Thus if, as above, a man gets 6 shillings an article and is expected to turn out nine a week, thus making £2 14s. 0d., and finds by increased energy or ingenuity he can turn out twelve, by

the bad custom mentioned above the clerks would reduce his price to 4 shillings 6 pence each, so that he would earn twelve times 4 shillings 6 pence (that is £2 14s. 0d.) as before. Thus it will be seen he gets no reward for his merit, only increased toil.

But on the American plan he would be paid 6 shillings for each of the nine articles, and for the extra three articles, perhaps 7 shillings each; so that his earnings would amount to a total of £3 15s. 0d. This is an increased inducement to a man to make efforts, and it pays the employers, for the three extra articles are made without any increase to their capital, salaries, or standing charges. Probably it would only be in the case of large and costly machine work that the extra payment would be actually as large as is indicated, but the same principle would always apply.

The bad customs above mentioned arise from the managers and foremen being too ignorant or too indolent to estimate by calculation what work ought to cost. To many this may seem a very exaggerated state of affairs, but I know it to be far more common than is suspected.

To show how utterly useless piece prices may become, I will give an instance which I heard not very long ago. Great pressure was brought to bear on a department of certain works, to produce a large increase of a very complicated article. Prices were reduced where possible, more machines put down, and yet the output seemed to rise very slightly. At last a man of some experience in such matters was requested to report what could be done to put things right. After looking carefully into the working of the department he reported much as follows: Many of the machines were in such a condition as to render it impossible to turn out good work without great care from the workman. The workmen were being paid for the number of articles passed through their machines, whether accurate or not. In some cases the prices were so low as to make it impossible for the men to make fair wages without turning out careless work, with the result that much of the work had to pass two or more times through certain machines, and other machines were employed entirely to correct errors in the work. Steps were taken to put the department into a better state of organisation. A sufficient staff of gaugers was employed, to gauge the work as it came from the machines. The workmen were paid only for the articles correctly machined. Some of the piece prices were increased. The result was an increased output of more than half, and the number of articles rejected for faulty machining decreased to almost nothing.

The important points then to be observed in working the piece-

price system on the semi-automatic machines are these: First, to keep the machines in a perfect state of repair; never to allow a machine to continue working if in bad repair, under the false impression that it cannot be spared. It is far more economical to stop the machine and overhaul it thoroughly than to allow it to go on running in a slip-shod manner. Second, never to allow the men to get the impression that if they make more than a certain amount of money in a week their prices will be reduced.

Cutting down prices must be done with great caution. Men are usually amenable to reason if there is a clear case and their side of the case is considered, and especially if it is discussed with them. At one time the writer introduced a system, which worked very fairly, for introducing improvements. Suppose a better machine was got, it would be pointed out to the man that much more work should be done, but that as every novelty wants some nursing to develop it properly, the following arrangements would be made: "For about a month we will not alter the piece rate; get the machine into order and turn out all the work; make all the money you can during that time; but after that we shall reconsider it entirely." I have always found this inducement quite sufficient to make a man do his best, for of course the machine was got to make money for his employer, and he has no guarantee that he will keep the job after the month (or whatever the time is) has elapsed. Another excellent plan is to give the articles to the workmen arranged in trays, so that they can see at a glance how many they receive, and return machined. This also prevents the possibility of men or boys losing or throwing away articles they have spoilt by careless work. Lastly, gauge the work when it comes from the machines, and do not pay for the pieces which are incorrectly machined owing to carelessness on the part of the workman.

We now come to the far more difficult question of the working of the piece-price system or premium plan with machines of the ordinary type.

Here so much depends on the skill of each individual workman that fixing a fair price becomes a far more difficult matter. I think in this case the premium plan is the most satisfactory to work, as if a price is fixed too low the man still makes his time wages, and if, on the other hand, the price is too high, the profit is not entirely taken by the man. As a rule, it may be said that although this class of work requires more skill from the workman, it does not require so hard work. In fact, more depends on the brain of the workman than on his muscle. This being so, some method of payment which encourages

this action of the brain must be a most beneficial thing both to employers and employees. At the present time, when wages for one class of work are kept so much on a level for quick and slow workers, it seems most desirable that the quick workers should have some way of making extra pay, and of showing themselves superior to the others.

The question, then, is how to fix a time for a piece of work taking perhaps a hundred hours to turn, which will be fair both to the workman and the employer. There are many foremen and managers who believe they can tell by looking at the piece to be turned how long it should take to machine. They may tell how long it *will* take, but very rarely how long it *should* take.

In my opinion there is but one way of basing such a price, and that way is by simple calculation. Given a certain machine and a certain piece of work to be done in it, knowing what depth and feed the machine will take on roughing cuts, also what feed can be run on the finishing cut (the speed will depend on the material), it is then an easy matter to calculate how much time must be spent roughing off the material and how much finishing, making allowances for changing tools, gauging, and any work not done by self-acting feeds, such as finishing a large radius. After a little experience the time for machining very complicated pieces of work can be found most accurately. When this method is carefully applied some astonishing things are brought to light. Work which it is supposed is being done quickly is found in reality to be taking perhaps twice the length of time that it should. I have come across many cases where the men working on time and far exceeding the estimated time, have declared they were working as hard as possible, and trusted foremen have assured me the men could not do better; and yet when the operation has been carefully watched the estimated time has been easily reached.

I think that if the premium plan were adopted and the times fixed on the above method, a great saving would be effected in many English workshops. There is no doubt that this method of carefully estimating the times required leads us to the most efficient working of big machines; as the portions of work to be assigned to the various saddles of, say, a big lathe, are calculated so that no saddle has finished its work before the other, and one saddle can be used perhaps for a long self-acting run while the man is working the other for screwing or some such operation that requires his constant attention.

How badly some piece prices are fixed may be gathered from an instance I came across not long ago. A turner had gone from one large engineering works to another, both doing the same class of work.

At the first he made on piece double the money he made on time at the other; the time he did the work in was the same in both cases, and the machines were also practically the same. There is no doubt he could have done the work in far less time, and would have done so, when working on piece, had he not known that if he made more than double pay his price would have been reduced.

There are many employers who would say that a rise of a matter of sixpence or a shilling a week to the workman would mean ruination to their business. I think that some of these masters might save, not sixpence or a shilling, but six shillings or more a week on each workman they employed, if they could see the advisability of thoroughly organising some system which would encourage the men to work their hardest, and with a keener interest in their work than is given by the ordinary time wages. Much can be done, even when paying time wages, by selecting a few of the best workers, and giving them a slight present of money as a reward for special attention to their work. I believe that such a gift made to a workman, unasked for, gives far more satisfaction than an equal increase of pay if the man has had to ask for it.

To work piece-price or premium systems advantageously, it is obviously necessary to secure the cordial co-operation of the workmen. Many trade unions have resisted the working of piece price on the ground that it is used to make men work harder and harder, the piece rates being reduced as they earn more, until at last the men can only earn the usual day's wage by working harder than is consistent with health. Some of the leaders say that they would not object to piece work, provided the man is guaranteed his time wages as a minimum. To this many employers object, as they think the man might idle his time; but it is difficult to see how this could be worse than if the man were on time work, which would be the alternative if he and his employer could not agree to a piece price. It will be noticed that the premium system described above obviates this difficulty entirely. I will say in conclusion that piece-price systems should not be looked upon as a method of driving down prices by excessively hard work on the part of the workman, but rather as a means of encouraging every workman to do his best and to take greater interest in his work, and of attracting and rewarding a superior class of workman, and by this means effecting a great saving to the employer.

# ARBITRATION OF LABOUR QUESTIONS NECESSARY TO INDUSTRIAL ASCENDANCY.

*By Charles Buxton Going.*

ILL it pay? Bald and sordid as the question may sound, it is the vital one for the advocate of arbitration to answer. Men are gaining a broader comprehension of what is implied by "paying"—are learning to look beyond the shop door and the end of the working day—to see that a man's labour is a physical expression of his life, and will never reach its possible maximum of efficiency until his body and mind are made and kept as efficient as possible. Advanced manufacturers generally are adopting a "humanitarian" policy which they would have rejected contemptuously very few years ago, and everywhere is apparent a growing appreciation of the necessity of acknowledging the ethical method as well as the cosmic in the government of industrial works; but this is simply because of the clearer vision which has been granted to, or forced upon, the world as to what really does "pay." The specifications are the same; the methods of testing only are different. The only demonstration needed to advance the cause of arbitration, then, is that, tried by the widely-comprehensive tests which the economic world has learned to accept, "it pays"—that, in the large, it increases the economy of production.

It is hardly more than a truism to say that the pursuit of economy is the controlling motive in modern life—at least on the material side. Economy is the quickening power in every movement of mechanical progress or industrial advance; it is the determining principle in the final ruling upon every case brought to the test in the progressive adjudication of social and industrial problems. Does this system, or that appliance, tend to cheapen production and to better the product? Then manufacturers may demur and labour may oppose, but the new

The accompanying paper is based almost entirely upon one presented by Mr. Going at the recent Chicago conference of the National Civic Federation for the discussion of Industrial Arbitration. The speakers there argued most fully the political and sociological aspects of arbitration. It is by its economic value, however, that it seems likely to win its way most rapidly in industrial life. With a view of advancing the appreciation of the essential economy of peace in the working world the paper is reproduced here, somewhat revised and expanded.—THE EDITORS.

practice will steadily dispossess the old, and in the end triumphantly prove its fitness by bringing in its train better things than it drives before it. This has been proved over and over again, and never more strikingly than within the century just closing. Methods of dealing with almost every phase of productive activity and contributory function have been revolutionised, all in the interests of greater economy. The whole history of the introduction of machinery, of its constant betterment, of its ever-spreading application, of its continual creation of widening fields for swarming armies of workers, is one great embodied sermon on the same text. Prevention of waste, reduction of friction, taking up of lost motion, averting of stoppage, concentration upon actually useful work, the production of more results and better results from less effort—these are the controlling lines by which the whole structure of modern industry is shaped.

It is needless, except by way of analogy, to recall the bitter opposition of short-sighted economists to every step of this progress. Sometimes vested interests and sometimes labouring classes have been marshalled in desperate resistance to apparently impending destruction, and have called upon society to save itself from crashing down in the ruin which would surely follow the attempt to replace so essential a part of its own structure. It cannot be pretended that individual hardship did not occur; but in the main the new institutions were largely modelled from the materials of the old, the benefits were immeasurably greater than the pains, and it soon became apparent that any sufferings caused by the changes were trifling, compared with those which would have followed the attempt to maintain an old system no longer adequate to the needs of the world. And so, ever justifying itself by its results, the progress of intensification in production has gone steadily on in the mechanical world, striving ever for the ideal of continuous operation at the maximum of economy, and finding, as it comes nearer to this ideal, continually rising gains for all—for the manufacturer, whose plant produces more units of profit-bringing product against a fixed amount of maintenance charges; for the operative, whose wage rises in proportion to his increased productivity; for the consumer, who buys more and more cheaply as competition between sellers forces prices down, parallel with the falling cost of manufacturing.

All this is familiar—almost hackneyed. It is summarised here only because it pictures most visibly the economic conditions of the times by which must be tested every matter offered for incorporation in the industrial system. Will arbitration increase the economy of

production—will it operate to prevent waste, to reduce friction, to take up lost motion, to avert stoppage, to concentrate effort upon useful work, to produce more results and better results from less total effort—in short, will it tend to yield the maximum of serviceable product with the maximum of satisfaction from the minimum of expenditure?

Can there be any answer to this but an emphatic "Yes?" Can there be any feeling but condemnation mixed with wonder toward a system which, in its present stage, spends exhaustive study in saving a fraction of a pound of coal burned under the boiler, and wastes unmeasured human energy wrangling with the fireman while the costly plant stands idle? Which spends unlimited money and brain power perfecting machines that can run continuously without stoppage for re-adjustment, and then tolerates weeks of inactivity while struggling over an adjustment with the machine tenders? Which "scraps" unhesitatingly tens of thousands in money's worth of transmission machinery in favour of a newer type giving a higher percentage of efficiency, and tolerates the wastage of hundreds of thousands in strikes and lockouts, brought on by clinging to an antiquated system for transmitting an understanding between employer and employees, which system has about as low an efficiency as possible? Would any sane Board of Managers attempt to run a railway, or start an electric-lighting plant, or operate a mill or factory, or send a liner to sea, with a mechanical equipment which was certain to break down periodically and lie in inevitable idleness until repairs could be patched up? And yet that is almost an absolute analogy to the status of labour conditions throughout nearly the whole range of such enterprises.

The explanation—at least a large part of the explanation—lies in the fact that progress has been too rapid to be symmetrical, and not unnaturally attention was directed first to those things which could easily be seen, felt, weighed. The physical elements of the manufacturing and transportation system have almost engrossed attention—the less material ones have received comparatively little systematic study. In fact, there has been a certain tacit acceptance of the idea that they were uncontrollable, and that salvation in the struggle for supremacy in industry was to be found through making the machine so perfect that its economy would offset the unavoidable losses from time to time caused by the unruliness and irregularity of the man. It is only lately, and still very imperfectly, recognised that there must be a fitting of methods of management to methods of manufacturing

—that upon the organisation of a great work of any kind even more than upon its equipment, depend its success or failure. The idea is spreading slowly: its apostles as yet are few, and their preaching is not always heeded. But the mechanical triumphs of to-day were won against equal skepticism. But a few decades ago it was "demonstrated" that no steamer could ever cross the Atlantic, because her engines would need more coal than she could carry. But a few years ago faith in the reliability of steam propulsion was still so weak that sails were retained. Electric light and power have hardly yet shaken off the suspicion of being incomprehensible, unreliable, and possible of ill repute. "Machine-made" has not quite lived down a suggestion of reproach. But the steamship and the dynamo and the machine won their way because they performed certain functions better, more cheaply, and in the end far more reliably, than the agencies they displaced. And so will a rational system of adjusting relations between employer and employee win its way against the wasteful, discordant, racking and wrecking methods now generally followed. The world is being rapidly aroused to an appreciation of the hideous wastefulness of war. The cost of it is creating a sentiment which the inhumanity of it never succeeded in making potent. South Africa and the Philippines, it is safe to say, are doing more to discourage war than all the disarmament advocates of the day, with the Hague conference thrown in.

But if war is being discredited politically, it is far more so industrially. We do not need to look far for an object lesson. England furnishes an example, full of meaning, of the mutual disaster to manufacturers and workmen which comes from the fight-to-a-finish method of adjusting labour troubles. It was perhaps the first instance large enough in proportions and clear-cut enough in its setting to be easily studied and correctly estimated. Most labour wars have been (broadly speaking) local, and while tolerably accurate figures of their cost have been presented afterwards by statisticians, no graphic representation of the effects was possible; standards of comparison were confused by similar trouble elsewhere in the country; comparisons with other countries were impracticable on account of national differences of conditions. But in England in 1897 the entire engineering trades, including practically all the mechanical industries which furnish the bulk of her export manufactures, became involved in a general strike and lock-out, which was fought to its finish in January, 1898. The scale of operations was national; the measure of consequences, owing to the late rapid extension of competition in

engineering work, was international. Labour and capital were both more thoroughly organised than ever before. The struggle was comparatively free from local violence, destruction of property, or direct physical loss. The "treaty of peace" seems to possess the elements of justice and common sense. Under it, according to an eminent British authority, work has since proceeded, "with very great freedom from disputes compared to any other period when there was an equal demand for labour."* This seems to be a result worth fighting for. What then is the "object lesson"—what was the loss which should discourage any future appeal to force in settling labour questions?

Simply this: that in that year of stubborn idleness England lost trade which she is likely never to regain; that since then, and largely because of the foothold in English markets gained during that time, the United States have passed England in the race for first place as an exporting country—a place which England had held so secure and by so long a lead that she considered it was "England first, the rest of the world nowhere." The price she paid for an archaic method of settling industrial disturbances was an apparently permanent reduction in the volume of her vitally-important export trade.

This is a matter which comes closely home to every one of the great industrial nations. A very great proportion of the present general prosperity, especially in the iron and steel trades, machine-tool trades, and metal-working industries generally, is due to success in securing orders in foreign countries. Gains in this direction are won in international competition largely by high adaptations of mechanical equipment and works organisation, and by the adoption of policies which secure the fullest possible accord and co-operation between employers and workmen in advancing economy of production. The United States had long concentrated their study upon these subjects, but the determining impulse to their industrial expansion was given when England, the long-recognised workshop of the world, stood idle and helpless to fill the orders of her patrons because her entire industrial machinery was stalled and deadlocked, trying to smash to pieces an obstruction, which, with a wiser policy ruling, might have been removed without stoppage. While British masters and men clinched and struggled, their customers went "across the way." And, as I wrote in THE ENGINEERING MAGAZINE last May:

"Trade, forced into new channels, is often loath to return to the old

* Sir Benjamin C. Browne, in the Works Management Number of THE ENGINEERING MAGAZINE, January, 1901.

ones. America was a permanent gainer by the long protracted British engineering strike. She would be a permanent loser by similar troubles at home. Germany, as a competitor, is keener and more strenuous even than she was two years ago. England, awakened in every part, has been undergoing a reorganisation approaching almost to an industrial revolution. Expansion in the machinery trades, which was won with comparative ease by the United States when the conditions were peculiarly favourable to them, would be hard to hold when the conditions were adverse—harder still, if once it slipped away, to regain from competitors who now blend the best America's mechanical skill has devised with a commercial system she can as yet but faintly parallel."

The land which is to gain or to maintain industrial supremacy must perfect methods of dealing between manufacturers and workmen as she perfects her methods of building bridges and locomotives. The operation of her factories and workshops must proceed as smoothly and continuously, with as little friction or heating or clashing, as do the sewing machines, the planers, the looms, or the engines with which she supplies the four quarters of the globe. She must hold to and extend the resort to reason, justice, and common-sense in the settlement of trade difficulties, so happily exemplified in the agreement reached last May in the United States between the National Metal Trades Association and the International Association of Machinists. She must send the lockout and the strike to the scrap-heap along with the thousands of other inefficient and obsolete devices she has thrown out of her shops. Their wastefulness is intolerable, and should be abhorrent.

The growing movement toward organisation, among employers and workmen both, affords the perfect machinery which should be installed in place of the old disorder. I believe that in the conferences of the leaders of manufacturers' and workmen's associations lies the complete solution of the matter. The overwhelming majority desire only what is fair and just, and in the organisation the few hot heads are harmless against the prevailing reason of their fellows. Most of the difficulties of the past have arisen from partial ignorance, on the part of each side, of the views, the difficulties, and the surrounding conditions of the other. Organisation facilitates association, and association promotes understanding. In this voluntary arbitration, in which the representatives of the co-operating parties—capital and labour, are their own arbitrators, I believe, lies the perfection of harmony and the completion of economy in the industrial world.

It was not by any elaborately devised arbitration board nor by any scheme of "compulsory arbitration" that final adjustment of the great British strike was reached; it was not through any mediation from without, formal or informal, that the threatened general struggle in the American mechanical trades was averted last spring. The medium of approach to agreement, on each side, was simply organisation sufficient to consolidate the respective sides into working units, coherent enough to insure unity of effort, concentrated enough to be brought together into a single field of mutual action, reaction, and influence. Reason, intelligence, and justice did the rest. Grant that, in the former case, reason did not prevail until force had been tried; it was the appreciation of the reason and not the mere yielding to the force which was apparent in the settlement, and this appreciation should last and not need to be renewed by another schooling so rough. Very probably if it had not been for the great preceding British labour-war, whose lessons were still so fresh, there might have been a national struggle between American engineering employers and workmen last summer. Very probably the English engineering strike was the chief thing which averted an American engineering strike. But so should it avert any similar future disaster, for now both sides of the matter are luminously displayed—the wreck of war, the triumphant success of arbitration.

I do not go so far as to say that it is never necessary to fight. The upholding of a principle may be worth anything it costs. Much of the priceless knowledge we have has been won out of the striving and suffering of battle. Many of the laws which will be recognised in the future adjustment of labour difficulties were proved only at fearful cost in by-gone strikes. But the body of experience now gained should make further contention almost, if not quite, impossible. Breaking tests are necessary to determine the strength of materials—but the engineer does not go on testing every individual structure to destruction. The old adage says: "In time of peace prepare for war." A newer paraphrase might be: "From lessons of war, prepare a stable peace."

# EDITORIAL COMMENT

The trend toward socialism in Germany, toward (at least) municipalism in England, and toward paternalism in the United States, is called to mind by an enquiry lately addressed to the editors for an "opinion as to the advisability of cities owning and operating the plants of such local industries as tend to become monopolies." The publications of THE ENGINEERING MAGAZINE upon this subject can have left no manner of doubt of our opinion; but this honest enquiry from an earnest student gives ground for recapitulating it.

* * *

There is, in our view, no conceivable disposition of semi-public works which is so certain to blight progress, to sterilise improvement, to discourage expansion, to dwarf development, and to antagonise economy, as is this same municipal ownership. One need look no farther than to electric traction in England, where it has been kept substantially in the hands of the municipalities, and in America, where it has been developed wholly by private enterprise, to find an all-sufficient object lesson. Not only is the British citizen left without proper urban transport, to his own great discomfort and to the oppression of the proper growth of his city, while the American even of the smallest towns has swift, satisfactory, and cheap travel everywhere about his streets and into the surrounding country. More than this; the British electrical industry, and the steam-engine makers who should profit by it, are so hampered by stagnation and lack of opportunity at home that they are hopelessly handicapped in external competition, and have to give way to American rivals even in home business. These negative results of inaction have probably cost England more than America would lose by the jobbery and robbery which, it is always asserted, would attend putting quasi-public corporations under city or State ownership in the United States.

* * *

Individual initiative, the incentive of individual reward, freedom to expand as far as economic conditions permit or can be made to permit, freedom to conceive great improvements, to plan great enterprises, and to dare attempt them for an individual prize proportionate to the gain brought to the world; opportunity to rise by virtue of one's talent, and certainty of receiving a due share of reward when one can lead his fellows into knowledge of some great advance in the economy of production—these are the influences under which every great achievement on the material side of civilisation is won. And these are the influences which government, with its inevitable bureaucracy and departmentalism, stifles with deadly certainty. Run over the list of men, now directing great private engineering works, who early left the army, the navy, or the civil service because it held no opportunity adequate to their powers. Conceive, if you can, of a Rockefeller, a Yerkes, a Lord Armstrong, or a Sir William Van Horne attaining his full growth in a government office!

* * *

The fear of monopoly is puerile. No franchise should be granted, of course, without assuring protection of the rights of the people; but immeasurably surer is the protection inherent in conditions of production and consumption. The man who had the genius to conceive the consolidation of the oil business, had the genius to go on with improvement after improvement, ever reducing cost; and he had the genius, too, to know that only by giving the consumer a large share of the advantage of every reduction could his output be marketed. The man whose mind could

grasp and organise a system of city tramways did not rest until electric traction, improved equipment, accelerated service, free exchanges and lowered fares, had made street travel more profitable for its owners to conduct, because cheaper and vastly more comfortable for its patrons to use, and therefore used to its full capacity.

* * *

The great results by which mankind is benefited are the tangible expression of the genius of great men, and the system which does not foster the growth of great men—which does not afford them unlimited scope—will not yield the great results demanded by modern conditions of life. Government ownership and operation of industrial undertakings does not afford this scope, because government is wholly misdirecting its functions in attempting the undertaking. Its only legitimate province, as Mr. Redfield says elsewhere in this number, is "to secure to citizens the right to accumulate property and enjoy the benefits of it." When it undertakes the actual conduct of industrial operations, it simply induces atrophy of that much of the social body, to the infinite harm of the entire tissue.

We undoubtedly need more *intelligent* government supervision of the vast corporations which exist by license from the public. We need above all, in the interest not only of the people but of protecting the corporations themselves from the conscienceless promoter, the political demagogue, and the pettifogging legislator, that there shall be the fullest publicity in the conduct and the systematic reporting of their business. But we do *not* want, and the healthy growth of the world's functions can not support, the blight of municipalism and State socialism.

* * *

A very interesting example of the working of the protective system has lately been brought to notice—an example which shows, more luminously than any length of argument could do, the speciousness of its supposed benefits and the hopeless partiality of its administration.

Beet-sugar interests have been urging the United States treasury department to abrogate the most-favoured-nation clause in Russo-American agreements, whereby Russian beet-sugar is now admitted at a low rate of duty. This would force it to bear the Dingley rates, which would amount to an effectual exclusion. The infant American beet-sugar industry, of course, is the object of the solicitude of the movers in the matter.

But alas! There is trouble in the nursery. This new baby is putting noses out of joint. Machinery makers cry out in distress that, if the Dingley tariff be enforced against Russia to exclude $340 000 worth of sugar, Russian retaliation, in the form of a 25 per cent. duty, will promptly crush the present export trade of American manufactures to Russia. This trade amounted to $10,000,000 in the fiscal year ending June 30, 1899, and is said to have reached nearly that figure in the first ten months of 1900—counting, in the latter estimate, direct shipments only, and not the large indirect trade passing through English and German ports. No wonder that there is sudden and startled appreciation of the fact that protection "comes high."

And this among United States manufacturers—the very shining examples of devotion to the protective-tariff cult and of the reward which is said to come to its votaries. Can it be, after all, that even avoiding the debated question whether the consumer does or does not pay the tariff—ignoring the discussion as to the effect of generally inflated values throughout a country and their influence for or against stability—there is yet something in these markets of the world well worth having and fully procurable only on a basis of free trading?

The industrial rivals of the United States will hope that the Government may rigidly uphold its time-honoured policy of protection; but the signs of the times are all the other way. Too many American manufacturers have tasted export trade and found it sweet; too many experiences are accumulating to show them that if they are to sell, the world over, without handi-

cap, they must be free to buy the world over without handicap. The scales are falling from their eyes, and they begin to see clearly the beauty of far-off fields which before they ignored. When American manufacturers begin to turn toward freer trade, the days of American high protection are ended.

* * *

The politician who has so carefully cultivated the popular American belief in protection and the horror of free trade has merely taken the cue from what he esteemed his most influential constituency. He will be keen to watch the faces of his supporters and to change his play when he finds—as many evidences are beginning to suggest—that the manufacturers of the United States are modifying their views. They are beginning to see that their prosperity has been caused not so much by protection from foreign competition as by free trade throughout their vast land at home. They are beginning to feel that the free trade which has made Britain so rich and powerful in industry and commerce is an essential to their own industrial expansion. And a few concrete instances, like that afforded in the case cited above, will do more to hasten the change than all the logical demonstrations ever uttered or written.

* * *

The subject of the origin of solar and terrestrial heat is a question which has peculiar interest for the engineer, and although the study of the problem is supposed to belong to the domain of physics and astronomy, yet it is altogether a matter for comment and reference in these pages. Of the various solutions which have been proposed, that of Mr. Cope Whitehouse, well-known on both sides of the Atlantic as a geologist and traveller of extensive experience and observation, demands attention. Mr. Whitehouse, in a recent communication, states his theory to be that the heat of the earth is not received direct from the sun by radiation, but is electrically produced, the source of energy being the earth's rotation. If it be assumed that there are magnetic lines of force extending between the earth and the sun, the rotation of an irregular body like the earth may be supposed to convert a portion of the energy into heat, and this Mr. Whitehouse maintains, is ample to account for the present temperature of the earth. Although this theory was made public in various ways several years ago, it has only found partial acceptance in scientific circles, and that by the reference to some of its features as possibilities. The recent position of Lord Kelvin that the interplanetary medium is not necessarily extremely tenuous, but may be rigid, is altogether in keeping with the theory of Mr. Whitehouse. Observations upon the diminution of temperature with elevation, show that the rate of diminution appears to be a function of the surface temperature, and this, together with the moderate te peratures of elevated plateaus, as compared with the much lower temperatures of isolated peaks of the same altitude, falls in well with the theories of Mr. Whitehouse The whole subject is one of immense interest for the engineer, and it is more than probable that the full solution of the problem will be made along lines of thought which have been developed in engineering practice rather than in the observatory or physical laboratory.

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In view of the possible or even probable development of the Pacific coast of the United States, it is of interest to note a very frequent misconception as to the relative latitude of the northern Pacific ports. Puget Sound, upon which are situated Seattle, Bremerton, Tacoma, and Vancouver, is generally considered to be well to the northward, and the casual individual naturally assumes this important body of water to be something comparable to the Baltic for example, or to the fiords of Norway.

As a matter of fact, as a glance at the map alone is needed to show, the latitude of Puget Sound is about 47½ degrees, or about two hundred miles further south than Land's End, the southern point of Great Britain, and more than five hundred miles further south than Glasgow. The

great capitals of Europe, London, Paris, Berlin, Brussels, Münich, are all further north than Seattle, which itself is hardly 120 miles further north than Venice.

The prevalence of a similar misconception as to the latitude of American cities on the Atlantic coast has only of late been dispelled, and it is fairly well realised at the present time that New York is on about the same latitude as Naples, and that London is as far to the north as is Labrador. With the development of the resources of the Pacific coast, the misconceptions now so prevalent will doubtless follow those which formerly prevailed with regard to other portions of America, and it is even now none too soon to call attention to facts which, if overlooked, might seriously affect enterprises of development and industry.

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The beginning of a new century has brought forth a vast amount of matter, retrospective in nature and form, much of it sentimental to the point of gush, and all of it of little more than passing interest. Such collections of recent history serve their passing purpose, and are then forgotten, as their form is necessarily ephemeral.

A far more permanent and useful record of the work which has made the end of the nineteenth century noteworthy, the work of the engineer, the applied scientist *par excellence*, is found in the columns of the Engineering Index, the continuous record of engineering development, as recorded in the pages of cnrrent technical literature

It is related that King George III once made the remark: "I have had occasion to consult the best lawyers in my dominions, and the ablest of them can do no more than refer!" He might well have said the same of a wider subject than the law, and what would have been true at the close of the eighteenth eentury is a thousand-fold truer at the close of the nineteenth.

The Engineering Index enables the engineer to refer, with a fullness and promptness which without its aid would be impossible; for no matter how fully a professional man may know his standard works of reference, it is a physical impossibility for him to keep in touch with the latest and fullest form of professional information, the current technical periodical press, except through the medium of such a record. With the completion of the third volume of the Index, now in course of active preparation, there will be placed in the hands of the engineer a retrospect of the work of the closing years of the century, which, unlike others to which reference has been made, will be of permaeent value and usefulness, alike a record of the past and guide for the future.

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One of the interesting features of the invasion of the markets of the world by German and American machine tools is the gradual breaking down of national characteristics in machine design. Formerly it was possible, and even easy, for the trained eye of the engineer to distinguish the nativity, so to speak, of a lathe, planer, or engine, not merely from positive details of construction, but mainly because of the general style of design.

Now, however, we are beginning to realise the advent of the cosmopolitan machine. American tools are no longer necessarily made in America, nor are all the British marine engines built on the Clyde or on the Tyne. American tools are beginning to partake of some of the English massiveness, while British machinery is losing some of its anvil-like solidity. The cab for the engine driver is no longer a characteristic of the American locomotive, nor has that country a monopoly of outside cylinders. In these, and in many other obvious ways, the influence of international competition and contact is apparent, and although the ultra-conservative may deplore the fading of local and national peculiarities, there can be little doubt that the whole result is for the decided advancement of engineering practice and commercial development. Let each take the best from all the others, and let the advent of the cosmopolitan machine tool be as welcome as that of all other friendly international relations.

# REVIEW OF THE BRITISH PRESS

**The Treatment of London Sewage.**

EVERYTHING which relates to the health and comfort of a great city is of such surpassing importance, both to the residents themselves and to the world at large, that the paper of Professor Frank Clowes upon the treatment of London sewage, recently read before the Society of Arts, and published in the *Journal* of the Society, demands extended review and abstract.

The population of London, exceeding 5,000,000, and forming at least one-eighth that of the United Kingdom, discharges the whole of its sewage into the river Thames within a short portion of its length, and since the river is the busiest waterway in the world, with a yearly tonnage of more than 23,000,000, the question of the prevention of a colossal nuisance is imperative.

At first the raw sewage was permitted to be discharged directly into the river in the neighborhood of the city, with the inevitable result that the heavier road detritus settled and tended to reduce the depth, while the putrescible matter floated, and, under tidal action, accumulated as a deposit on the foreshores.

In order to reduce these offenses the delivery was removed to a point about fifteen miles below London, and, after this was found insufficient, the sewage was subjected to chemical treatment and sedimentation before it was allowed to flow into the river. The treatment consisted in straining off the larger solid matters, and then mixing the sewage with solutions of lime and sulphate of iron; the chemical precipitate was then allowed to settle by sending the sewage on its way to the river slowly through parallel channels. The screenings were disposed of by being dug into the ground; the settled matter of sludge sent in tank steamers to be discharged out at sea beyond the mouth of the river; and the fairly clear effluent discharged into the river in two streams, which jointly deliver more than 200,000,000 gallons every twenty-four hours, and constitute the most important tributaries of the Thames below London.

This effluent, however, is only clarified sewage, and contains a large amount of putrescible material in invisible solution. As long as putrefactive changes are delayed by low temperatures, and an ample flush of upper river water comes down to dilute the effluent and carry it out to sea, no sensible foulness occurs. In summer time, however, the high temperature hastens putrefactive change, and when the flush of water from the upper river is diminished, evidence of foulness is apparent. This foulness must be expected to increase with the growth of London, and hence the importance of adopting without delay a method of sewage treatment which shall meet the requirements of the increasing population, and also secure a greater degree of purity than is possible with the present system.

The Main Drainage Committee of the County Council has had this matter under consideration since 1893, and a number of reports, based upon the researches of Dr. Dibdin, Professor Clowes, Professor Frankland, and others, have shown that the settled sewage may be purified to a very high degree by encouraging the spontaneous purifying action of the bacteria which are present in the sewage itself. The effluent thus produced, without the intervention of chemicals, remains free from foul putrefaction, and is able to support the life of fish, and is in all respects greatly superior to that produced by the older method of chemical treatment. The minute vegetable organisms, known as bacteria, exist to the average number of 300,000 to the drop of sewage, and only require to be placed under suitable conditions in order to effect the rapid and inoffensive resolution of the putrescible matters of the sewage into harmless and inoffensive products.

The method proposed by Dr. Frankland for enabling the bacterial purification to take place consists in passing the liquid

through coke beds upon which the bacterial formations have been made. The sewage is allowed to flow into large tanks containing fragments of coke about the size of walnuts. When the level reaches the upper surface of the coke bed the flow is stopped, and the liquid allowed to remain in contact with the bacteria coke surface for two or three hours. The effluent is then drawn off, and the coke bed allowed to rest for three to seven hours, when a new charge of sewage is introduced. The introduction of bacteria from the sewage, and the periodical supply of oxygen provided by the aëration periods, maintains the purifying action. In such a purifying tank it is desirable that the raw sewage should first be rough-screened, and subjected to sedimentation, in order to remove as much as possible of the suspended solid matter, which would tend to choke the coke bed. The dissolved matters and the small amount of suspended matter remaining after these preliminary processes are then readily dealt with by the bacteria of the coke-bed, and no choking of the beds occurs. Careful examination of sewage thus treated shows that more than one-half of the dissolved matter of the original sewage has been removed by the bacteria, and that the portion which has been removed is mainly the matter which would have become very rapidly offensive and lead to the de-aëration of the river water if it were allowed to pass into the river.

"The introduction of such a sewage effluent into the lower Thames is unobjectionable. The river water at the points where the effluent is discharged is uniformly muddy; it is always brackish and frequently salt to taste, owing to the presence of tidal sea water. It is, therefore, not capable of being used for drinking purposes. The effluent would certainly cause no deposit upon the river bed, and would ordinarily tend to render the muddy water more clear by mixing with it. No offensive smell would be emitted by the effluent, as it is discharged into the river. And, although the effluent contains more organic matter than the river water does, the bacteria which it contains would slowly and inoffensively remove this organic matter from the effluent after it has been introduced into the river. The effluent would be suitable for the maintenance of healthy fish life."

**Electrical Locomotives and Multiple Driving.**

In considering the application of electric traction to main line railways, the question of the manner of applying the power is sure to attract attention. Everyone is so accustomed to the steam locomotive that at first it seems a matter of course that if it is to be superseded it will be by some other kind of a locomotive, and hence the electrical locomotive has been assumed to be the coming machine. This view has been strengthened by the fact that the limited use to which electric traction has thus far been applied in main-line service has been for tunnel hauling, or similar special work, where a temporary substitute only was required for the steam locomotive, and where electric locomotives necessarily have been used.

The experience of tramway service, however, has shown the capabilities of independent axle driving, and the fact that electrical engineers, well versed in heavy tramway practice, have advocated the application of improved modifications of this system for main line service, brings the two methods directly into the field for discussion.

A recent paper by Mr. Edward H. Tyler, published in *Engineering*, advocates the electric locomotive, and brings forward some excellent arguments in its favour. Mr. Tyler examines the subject entirely on its merits, and states the subject in the following classification:

"1. The problem of applying sufficient power to heavy trains with high acceleration.

"2. The question of economy, by reducing the total weight of train and locomotive.

"3. The subdivision of trains into self-propelling units.

"4. The possibility of being able to control the trains from either end.

"That these factors will vary in relative importance, according to the circumstances of the railway to which they apply, is obvious. There are, besides the above-mentioned factors, general considerations depending on convenience rather than on essentials; and as these will vary in every case, it seems clear that a decision as to the best system to adopt can only be arriv-

ed at after an examination of all the circumstances. The alternative methods of electric haulage may be classed as follows:

"1. By locomotives.

"2. By motor-coaches at each end of the train, the leading motor-coach hauling the train, and the end coach trailing, or both ends working.

"3. By independently driven axles throughout the train, controllable from either end only.

"4. By independently driven axles throughout the train, each unit having its own controllers, which are actuated from master-controllers from either end of the train.

"So far, the locomotive system holds the field in almost every case where electric train haulage has taken the place of steam. That is to say, for trains of 100 tons and upwards. It is only fair to say that the system has been rather imposed than chosen. The feature of railways, as distinct from tramways, is that each company is merged in one vast network of lines, over which neighbouring companies run their rolling stock, without regard to the limits of their own systems. It follows that, pending the universal adoption of electric traction, which is not even in sight, the service will be a mixed one, and it will be necessary to handle the ordinary rolling stock of any company possessing running powers. The only means of applying electric traction to this influx of through trains is by electric locomotives. The electric locomotive, therefore, has its reason for existence, and in spite of the competition of other more loudly-voiced methods, it is not likely to be superseded for many years."

There are disadvantages, however, in the application of the locomotive system to heavy electric traction, as Mr. Tyler points out.

"The weak point of the electric locomotive is rather its limitations in the direction of tractive effort than as being an unnecessary weight. It has been generally assumed that, as regards application of power to the wheels, the electric locomotive is easily ahead of its steam brother. As a matter of fact, the restrictions of space and the limitations of the permissible voltage of the current, place the electric locomotive, if comparison is made, somewhat at a disadvantage. The space available on any one axle of the locomotive is strictly limited. If geared motors are employed, the gearing takes away so much of the space along the axle. The clearance from the height of the rail limits the dimension as to diameter, and no considerable relief is to be obtained by increasing the diameter of the driving wheels, since by doing so the gear ratio is affected unfavourably."

If the electric locomotive is not to be used, the separately driven axle system must be considered, and this may be either a mere collection of motors, distributed uniformly throughout the train, controlled as a whole from either end of the train; or, it may be the "multiple-unit" system, which consists of a train composed of independently equipped coaches, which, being coupled up mechanically and electrically, form a train having the same tractive characteristics as any one coach.

The conception is a bold one, and the embodiment of it is, perhaps, the most wonderfully and perfectly complex mechanical organism that the ingenuity of man has ever produced. Its scope, plainly, is in the field of electric tramways, where single motor cars, converging on to some main artery of traffic, are coupled together, and despatched at a high speed on a suburban line, which is, to all intents and purposes, a high-speed railway.

The characteristic of the system is not the availability of passenger weight for adhesion purposes, nor yet the subdivision of power for the purpose of space. These are its attributes. But the distinctive feature of the system is its capacity to form, and then disperse. Where this feature is desirable, the multiple unit system offers such inducements that its adoption is only a question of time.

For suburban railway service, such as we now know it—namely, for long trains starting from terminal stations with their full complement of passengers—the question of breaking up of trains does not come in. It is conceivable that it might be desirable in some cases, but in the great majority of cases the long close-coupled made-up trains are the only arrangement that can cope with heavy traffic. If the trains are not to be broken up, there is no object in equipping the train with controllers, master-controll-

ers, and all the necessary air or electrical connections, as the case may be. It is not to be forgotten that all apparatus, and especially apparatus on which the lives of men depend, must be frequently, even daily, overhauled. The fewer units the easier will be the work of inspection and repair. It is, therefore, hardly conceivable that multiple unit control will be adopted for made-up trains, merely because it is a very perfect method of controlling a number of motors. There are simpler methods of controlling a number of motors from either end of a train, which are quite as perfect under the simpler conditions of made-up trains as the multiple unit system.

Mr. Tyler seems to have a leaning toward the electric locomotive, which is, to a certain extent, borne out by his argument, but it seems as if the influence of the precedents of steam practice have much to do with this predeliction.

"The conclusions the writer arrives at are, therefore, these: Where the total effort required is not more than can be exerted by a 50-ton locomotive, equipped to haul up to its full limit of adhesion, and where the question of control from either end without shunting is not an essential, the separately driven axle system does not offer any advantages commensurable with its greatly-increased complication. Where the power required is in excess of the above, the alternative lies between multiple-driven axles and coupled locomotives. The general question of convenience would even here seem to pronounce in favour of the coupled locomotive. There is an undoubted advantage in having the equipments separate from the coaches, so that a defective locomotive may be replaced without breaking up a train. If, however, the trains must be controllable from either end, then some kind of multiple-driven axle arrangement is necessary; although if the traffic is frequent enough to make shunting impossible, it should be worth while to end the line in a loop connecting the up and the down rails."

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**Large Gas Engines for Central Stations.**

THE probability that the construction of stations for generating electricity in bulk for commercial distribution will soon be as common a thing in England as it has become elsewhere, renders it desirable that the choice of motive power for such stations be discussed. For this reason the paper of Mr. H. A. Humphrey, upon the use of power gas and large gas engines for central stations, recently presented before the Institution of Mechanical Engineers, is an acceptable contribution to the study of power generation.

After pointing out the additions to lighting and tramway work now under way or consideration in Great Britain, Mr. Humphrey goes on to show that it is not for these purposes that the real bulk of energy will in the approaching future be required, but rather for manufacturing purposes.

"When electric energy can be generated and distributed at such a cost as to displace the use of steam power plants now operating in manufacturing works, the inauguration of a new era of centralisation in the supply of power will have commenced. The average total cost of a unit of electricity (kilowatt-hour), generated by electric-supply undertakings in Great Britain for 1898 was 2.81d., of which the expense of generation amounted to 1.79d.

"With improved load-factors this figure would be less; but those who know the actual cost of steam power generated on manufacturers' premises will appreciate how much this figure must be lowered, if the manufacturers are to be induced to take electric energy in bulk from outside companies. It is known that several companies will, under certain conditions, supply electric energy for power purposes at 1d. per unit, this being possible because of the higher price paid for lighting current; but even this figure is too high for manufacturers who would require large currents. The approximate cost of power computed under different circumstances shows that, unless the price is reduced to something like ¾d. per unit, only the smaller manufacturers will benefit by the wholesale adoption of current supplied from central stations.

"Where, then, is this cheap supply of electric energy to come from? In Great Britain we have not the Niagara Falls, with their 7,000,000 horse-power, to draw upon, or even the 600,000 horse-power of waterfalls said to be available in Switzerland, and it is certain that we must rely on the coal supply as the only cheap source of power available in really large quantity."

Until recently the gas engine was thought only fit for small powers, and this, together with the high cost of illuminating gas, rendered gas power unimportant for central-station use. With the introduction of cheap fuel gas, and the development of the large gas engine, the situation has been changed. Gas producer plants, such as the Mond, in which the ammonia is recovered as a by-product, and others, have been perfected to the point of full commercial practicability, and the large gas engine is now an accomplished fact.

"The special features of gas engine practice, which have enabled gas engines to be made of powers far beyond those formerly thought possible, may be briefly stated. The most important is the improvement in the design of the cylinder liner, the piston, and the valves, whereby they may all be efficiently water cooled; and probably a time will soon come when no engine of more than 17 inches cylinder will be constructed without a water-cooled piston and a high degree of compression. The better shape given to the clearance space, the disposition of the valves in this space, the introduction of induced and positive systems of scavenging, and the better understanding of the causes of pre-ignition, have all aided in the forward progress of the gas engine, and a noticeable strengthening up of all working parts has taken place. Thus the Westinghouse practice is to make the crank-shaft half the diameter of the piston, and in larger sizes even more. For example, with a 34-inch piston the crankshaft is made 9 inches in diameter. Improvements in the breech-end castings, better arrangements for the contraction and expansion of the metal, improved means of ignition, and items of this nature are too numerous to mention, but all help in marking a step-by-step progress in the attainment towards gas engines of great power."

In order to show the extent to which the successful construction of large gas engines has been carried out, Mr. Humphrey gives data of tests of a Crossley engine of 400 h. p., operated with Mond producer gas. The results of this, and other tests, are tabulated very fully in the paper, and only an abstract is given here.

The Mond gas consisted of about 15 per cent. carbon monoxide, 11 per cent. carbon dioxide, 29 per cent. hydrogen, 2 per cent. methane, and 43 per cent. nitrogen, and a calorific value of about 90 B. T. U. per cubic foot.

At normal load, the engine used 60 cubic feet of this gas per indicated horse-power-hour, this being equivalent to a thermal efficiency of 26.2 per cent.

"It was anticipated that the large Crossley engine would give fully 30 per cent. thermal efficiency; but the makers have kept down the degree of compression to so low a figure that the average effective pressure is only a little above 60 lbs. per square inch. Although this engine has to run at full load day and night, this extreme measure of precaution would be quite unnecessary, if the pistons were water-cooled. However, it is the first engine of its size Messrs. Crossley Brothers have made, and they are to be congratulated on having turned out a workmanlike and successful engine. More economical results are expected from the 500 horse-power 'Premier' gas-engine, which, unfortunately, was not delivered early enough for the tests to be carried out and the results included in the present paper. This engine, when tested at the Premier Company's works at Sandiacre, with Mond gas, showed a mean effective pressure of 103 lbs. per square inch, but there were no means of accurately determining the gas consumption. It is expected that 650 horse-power will readily be obtained from this engine, which is now one of the largest two-cylinder engines in existence."

The crucial question in the problem is the net cost of the current per unit as compared with plants using steam power. Mr. Humphrey's estimates on this point are based upon experience with the Mond gas plant at Winnington, where 150 to 230 tons of fuel are gasified per day. Assuming a central station gas engine plant of 20,000 horse-power, the details of cost are worked out for various prices of slack, and for load factors ranging from normal to 33 1-3 per cent., with the result that the total cost in pence per kilowatt-hour at normal load ranges from 0.082d., with slack at 3s. per ton, to 0.166d., with slack at 10s., these figures including no charges on capital account, rent, rates, or taxes.

Mr. Humphrey's paper gives much valu-

able information concerning trials with other gas engines, including Westinghouse, Delamare-Deboutteville-Cockerill, Oechelhaüser, Otto, and others, and forms a valuable contribution to one of the most important present subjects in the domain of mechanical engineering.

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**The Manufacture of Iron.**

In his presidential address, delivered before the Institution of Junior Engineers, Sir I. Lowthian Bell gives some interesting comments upon the development of the manufacture of iron, from the crude beginnings of earliest times down to the present. The distinguished part which he himself has borne in the development of the iron manufacture gives especial weight to the utterances of Sir Lowthian Bell, and abstracts from his address are of interest.

After treating of the probable conditions under which iron ores were formed, Sir Lowthian Bell referred to the early bloomaries, identical, doubtless, with the methods of prehistoric ages, remains of which have come down to us, and similar to those used by tribes in the interior of Africa when first visited by civilised men. The introduction of coal for charcoal by Abraham Darby, in 1735, made the earlier blast furnace free from the difficulties involved in the use of charcoal, and the invention of the hot blast by Neilson, in 1828, was the next great improvement. While fully appreciating the value of the hot blast in reducing the cost of pig iron, Sir Lowthian Bell affirms that the chief loss of fuel in the cold blast furnace was really due to its lack of capacity, by which an enormous waste of heat resulted from the high temperature of the escaping gases.

About 1850 there were few blast furnaces exceeding 50 feet in height, with a capacity of about 6,000 cubic feet; the weekly production of such furnaces being about 150 tons, with a consumption of about 40 cwt. of coke per ton of metal, with a blast at about 600° F.

About ten years later Mr. John Vaughan erected a furnace a little more than 60 feet in height, and found in it a notable economy of fuel. After examining this furnace Sir Lowthian Bell designed one of 80 feet in height, and a study of this furnace, supplemented by laboratory investigations, showed a number of interesting conclusions.

It was found that the saving in fuel corresponded to the exact amount of heat brought in by the blast; that the action of that part of the furnace within 8 to 10 feet of the tuyeres was confined to intercepting the vast quantities of heat generated at or close to the tuyeres; that when the reduction of the iron has proceeded to an extent which ends in one equivalent of carbon escaping as carbonic acid to two of carbonic oxide, further power of reduction ceases; and that no increase in height above 80 feet would be attended with any economy, the effect of such addition being merely to raise the zone of production.

After referring to the work of Henry Cort, in the introduction of the puddling furnace, in 1784, the work of Bessemer, and the development of the Bessemer process, was discussed at length. Sir Lowthian Bell admitted that he himself was incredulous as to the possibility of the production of malleable iron in the Bessemer converter, and it required absolute demonstration to convince him of the truth. The account of the aid which the discovery of Mushet as to the use of spiegeleisen rendered in connection with the Bessemer process is of much interest, and confirms statements from other sources as to that portion of the development of the process. Perhaps the most interesting portion of the address is that which relates to the present and future competition between Great Britain and the United States in the production of iron. Comparing Middlesbrough and Pittsburg as characteristic centers of iron production on both sides of the Atlantic, it appears that in America about one-half the amount of raw material is required for the production of a ton of pig iron that is necessary in England. In America, however, the distances over which the material has to be transported to the furnaces, combined with the distance of Pittsburg from the points to which the product must be carried to compete with British iron, renders final the cost of the minerals, mining and carriage included, which are consumed for each ton of pig iron at Pittsburg and Middlesbrough, respectively, almost identical in the two localities.

Sir Lowthian Bell, however, admits that

he has not been in America himself since 1890, and during the past decade the improvements in machinery for transporting and handling minerals, particularly in the iron trade, have effected transformations hardly intelligible to those who have not had the opportunity of examining them. There is no doubt that the productive capacity of the United States, so far as concerns pig iron and its products, such as rails, structural material, etc., far exceeds its own normal consumption, and under these circumstances the invasion of British markets is inevitable, and the problem will settle itself according to the inexorable laws of supply and demand.

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**The Distillation of Water for Ice-making.**

In the manufacture of artificial ice it is especially desirable that the water should be pure and free from air, as otherwise the ice is cloudy and unattractive both in appearance and quality. Clear ice can be produced from water in its natural state if the supply is pure, by the use of special agitating appliances to expel the air during freezing, but the preferable method is to distill the water, as it is then pure beyond question and also free from air. The principal difficulty is regard to distillation of water is the cost, but this may be kept within reasonable limits by the use of improved apparatus, and hence the paper of Mr. Ral Williams, presented before the Cold Storage and Ice Association, and printed in *The Engineer*, is worthy of comment.

The most usual arrangement is one in which the exhaust steam from the engines is condensed and purified, live steam being added to make up any deficiency. In such apparatus the steam is passed through a scrubber, to remove most of the oil and other impurities, after which it is condensed in a surface condenser, and the condensed water is then reboiled in a separate vessel by means of a steam coil. In this latter operation the air is driven off, and grease and other solid matter is skimmed off, after which the water is cooled, filtered, and stored for use. By this method the cleanliness of the water is dependent upon the re-boiling, and there is often a taste of oil left in the ice, and the method is not the most economical, since no use is made of the latent heat in the steam.

The most economical method, as Mr. Williams points out, is to employ multiple-effect evaporators, such as have long been used to great advantage in the manufacture of sugar. In the triple-effect evaporator, for instance, exhaust steam is passed through tubes surrounded by water, and the vapour thus produced is passed through similar tubes in a second evaporator, and the vapour in this again through a third evaporator. The final vapour is drawn off into a condenser and removed by an air pump, so that there is a progressive vacuum in each evaporator. The condensed steam from the first effect is returned to the boiler as feed, while that from the second and third and the condenser is filtered and used for freezing. In this way the latent heat given up by the vapour in condensing is utilised to evaporate more water, and a high degree of economy is attained. Combinations as high as sextuple effect, on this principle, have been employed; with a triple effect one pound of steam will produce 2½ pounds of distilled water, and a sextuple effect will produce 4½ pounds of water from one pound of steam. It is, of course, desirable to operate an evaporating apparatus with the exhaust steam from the engines, but this involves a certain amount of back pressure, which is sometimes objectionable. Live-steam effects are therefore sometimes employed, although they cannot compete in economy with exhaust-steam apparatus, but are applicable in cases where only a small portion of the ice produced is made from distilled water, as then the main engines can be worked condensing, and a corresponding economy secured.

Mr. Williams describes several varieties of evaporating apparatus, including sextuple-effect devices to be used with live steam, and employing the so-called "film principle" of evaporation, by which excellent results have been obtained.

The paper concludes with a comparison of the cost of distillation of water by four different methods, the first being by the direct condensation of the exhaust steam from the engines, and first described above; the second the triple-effect, using exhaust steam; third, the triple-effect using live steam, and, fourth, the sextuple-effect, the computations being reduced to the same basis in all cases.

Comparing the cost in coal of distilling 50 tons of water in each case the relative values, taking coal at 10s. per ton, are:

| | £ | s. | d. |
|---|---|---|---|
| No. 1 plant costs in coal per 24 hours | 3 | 2 | 6 |
| No. 2 plant costs in coal per 24 hours | 2 | 4 | 0 |
| No. 3 plant costs in coal per 24 hours | 2 | 18 | 0 |
| No. 4 plant costs in coal per 24 hours | 2 | 8 | 0 |

The superior economy of the second apparatus is due to the combination of triple effect with exhaust steam, while the same efficiency is nearly attained in the fourth by the sextuple effect, even though live steam is employed.

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**Education and Trade.**

It is refreshing to find in a recent editorial in *The Engineer* a very sensible view of the relation of technical education to commercial supremacy. It has been dinned into the ears of the British public from many quarters that it is the superior technical training which has enabled Germany and America to enter England's markets; and the necessity of providing some form of education which shall provide the antidote, is a frequent cry.

At the same time concrete examples of the actual effect of the German or American educational methods upon commerce and manufacturers are decidedly lacking. The introduction of aniline dyes is quoted as an example of what scientific research has done for German trade, but after this is quoted there is a hesitation and doubt as to what else to name.

With regard to American competition, there are doubtless some excellent American machines, tools, etc., in the market, but it has yet to be shown that these are anything but the results of the experience of American mechanics, rather than directly due to any especial scientific training. It is rather urged that American success is due to general intelligence, but it has yet to be shown that this is specifically true, and indeed all statements of the sort are vague generalities.

The great mistake made by critics of British trade is that of comparing it with America and Germany of a few years ago. For England to have maintained her relative position of a short time ago it would have been necessary for her trade to have increased in a far greater proportion than that of the rival countries. If British trade was double that of America twenty years ago, and America's trade has increased twenty fold since then, British trade would have had to increase forty fold to preserve the same relative position. On the contrary, if the lead only was to be maintained, there would need to be only a small actual difference. It is not to be expected that a comparatively old country should maintain the same rate of progress as that of a far younger country with unlimited possibilities and a limitless area. The real question is not whether America and Germany are improving their markets, but whether England is improving hers. To assure this several things must be done.

"Improvement of the artisan will help, technical education will help, but more than anything success will depend upon commercial astuteness. It is that, and that almost entirely, which has given America and Germany their success in late years. Their goods are not better than British goods, but they know how to sell them; their knowledge is no greater, but they use it more wisely. What should be established are more schools of commercial training—schools where the art of selling will be taught and the art of organisation will be a feature of the curriculum. It will be useless to be provided with splendid methods, with clever workmen and excellent tools, if with these are not provided the means to induce the markets to accept the goods.

With this increased commercial intelligence must come also increased knowledge of modern methods of works management. Astuteness must come not only at the selling end, but also at the manufacturing end. It will not do to have the best products if they cost more than they can be sold for, and the goods must be reduced in cost without reduction in quality. Here the manufacturing skill must come in, and by repetitive process, automatic machinery, systematised methods, and accurate shop accounting and cost-keeping, the product may be made with British thoroughness combined with American ingenuity and German skill, and it can then be sold in any market in the world, in competition with any rivalry.

### The Electrical Equipment of Modern Warships.

THE general introduction of electricity in nearly every branch of industry during the past decade is well known, and one of the most striking examples of its importance is found in marine, and especially in naval service. For this reason a paper upon the electrical equipment of modern warships, recently presented before the Society of German Electrotechnologists at Kiel, by Naval Constructor Grauert, and published in the *Elektrotechnische Zeitschrift*, is of much interest.

The progress which has been made in the use of electricity on shipboard is seen when it is observed that the first use of current, in the German Navy, being that for electric search lights, was made in 1882, and that the first German cruiser to be fitted with electric lighting was the "Bayern," in 1887. This plant consisted of three dynamos of 33 kilowatt capacity, and included 225 lamps of 10 candle power and a total length of conductors of about 4,500 metres. In addition to the general lighting, there were two search lights taking 70 amperes at 50 volts, and some signaling apparatus. This installation cost about 23,000 marks, not including the search lights.

It is interesting to compare this early plant with that on the "Fürst Bismarck," one of the latest installations in the German Navy. Here the generators have a capacity of 325 kilowatts, operating about 900 lamps, as well as 44 motors aggregating 150 kilowatts, 5 search lights, and numerous signal, telegraph and telephone systems. The wiring makes a total of 33 kilometres, in which the multiple-wire cables for the telegraph and telephone systems are counted as single lengths.

This plant weighed 103.5 tons, of which 40 tons consisted of cables, and exclusive of the 5 search lights, which cost 60,000 marks, the total cost was 220,000 marks. These figures show better than anything else the progress which has been made in the use of electricity in the navy during the past decade.

This general introduction of electric appliances is due to the many advantages of electric transmission. For power transmission electricity replaces steam, and thus does away with the heat emitted by steam pipes, the electrical conductors also being much lighter, taking up less space, and being more readily installed. There is little trouble in keeping properly protected wires in good order, while the danger in case of damage from shot during battle is much less than is the case with steam pipes, and repairs are more readily made on board.

As already indicated, the first use of electricity on shipboard was for lighting, including both general lamps and search lights, and at first the appliances were very primitive in construction and arrangement. At the present time the arrangement resembles more nearly that of a stationary power station. The lighting itself is divided into a number of kinds, including the signal lights, both fixed and intermittent, these being generally controlled from a special switchboard placed in the conning tower or chart room. The use of electricity for power transmission followed naturally upon that of lighting, and has by no means yet reached its limits. Motors have been found especially convenient for driving ventilators, operating ammunition hoists, coal hoists, and small windlasses. For the heavier windlasses, anchor hoists and steering gear, and for the manipulation of heavy guns, steam or hydraulic power yet retains place. The further use of electric power is partly governed by the intermittent character of most of the work, since the generating plant must be made large enough to meet all the demands which may be made upon it, and this, during action, may include nearly all the motors, while during general service much of the machinery remains idle. An important de-

partment of electrical work on shipboard lies in its use for the transmission of orders, not only for the navigation of the vessel, but also for the action of guns, torpedoes, etc., etc.

The mechanical "telegraphs" used in the merchant marine for communication between the bridge and the engine room are well-known, and consist of two dials fitted with pointers which indicate the directions to be sent, a mechanical communication of light shafting causing the pointer in the engine room to follow the movement of the handle fitted to the dial on the bridge. Electrical devices of similar action have been made, in which electricity acts to replace the connecting mechanism. For the communication of special orders, for which optical signals are unequal, some form of acoustic device is used. Formerly speaking tubes were used for this service, but the increasing length of vessels, and the many bends and angles found necessary, have made these unsatisfactory. The loud-speaking telephone of Siemens & Halske has been found a most satisfactory substitute for the speaking tube, and on the "Fürst Bismarck" there are 57 single and 6 multiple sets of these telephones.

Electric heating and cooking have as yet found but few applications on shipboard, the cost being greatly in excess of steam, and as this latter is always available it will probably continue to be employed.

Herr Grauert gives designs of switchboards used on several of the most recent vessels in the German navy, and examples of the methods of wiring. Among the latter may be mentioned the protected central gangway on the "Kaiser Wilhelm II.," through which all the main cables are run, thus avoiding the usual intricate and inaccessible runs otherwise unavoidable in wiring a vessel.

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### The Measurement of Steam.

In determining the volume of water delivered in a given time, the well-known methods of measuring the velocity and cross section of the stream may be used, or the method of a weir is employed, while for a permanent gas there are various forms of meters, as well as the method of delivering the gas into a holder of known dimensions. For steam, however, the usual method of measuring the volume delivered is to deduce it from the measured volume of water evaporated or from the amount of water produced by the condensed discharge. Neither of the latter methods is altogether satisfactory, and hence the discussion of a direct system measuring both the quantity of steam delivered in a given time, and the rate of delivery at any instant, by means of the Gehre steam meter, contained in an article in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure,* by Herr L. C. Wolff, is of interest.

The principle of the Gehre meter is that of the drop in pressure when a flow of steam occurs through a contracted aperture. The simplest means of computing the velocity of flow under these conditions is by what is known as Napier's Law, formulated by Zeuner in his treatise on Technical Thermodynamics. The Zeuner-Napier formula enables the weight of steam discharged per second through a given opening to be found with a very close approximation to accuracy, the computation being facilitated by tables, adapted for differences in pressure ranging from 1-100 to 1-10 of an atmosphere. Within these limits the discharge is practically independent of the absolute pressure, being governed only by the difference in pressure on the two sides of the contraction. By assuming a small difference in pressure the formula is greatly simplified, so that for all practical purposes it is reduced to a matter of simple multiplication.

In order that no arithmetical operations may be necessary, the meter is arranged with a mechanical device by means of which the weight of steam can be determined by the examination of a recorded diagram. The apparatus by which this is accomplished is very ingeniously designed, and for the details reference must be had to the original paper. Since the formula involves variables, which, when graphically plotted, appear in the form of curves, this must be provided for in the instrument, and so properly curved templates are used, which enable the direct rise and fall of gauge pistons, acting in direct proportion to the variations in pressure difference, to record upon a moving sheet the ordinates corresponding to the flow at every moment.

The position of the recording point thus gives the rate of flow at the moment of observation, while the total delivery of steam in any extended period is obtained by measuring the area of the recorder diagram by a planimeter, in a manner similar to an indicator diagram.

The simplicity of the apparatus is remarkable, and the accuracy of its readings has been tested by repeated measurement of volumes of steam which were subsequently condensed and weighed. In the earlier instruments the error sometimes reached 5 per cent., but with the perfected apparatus it is kept below 1 per cent.

The usefulness of such a steam meter will doubtless be appreciated by many engineers. It has been possible to compute with more or less accuracy the amount of steam used by a steam engine from the indicator diagrams, but there are many other important applications in which no such method is possible. Thus in the case of steam heating, cooking, drying, etc., etc., it is often most desirable to be able to measure the quantity of steam, while in engine tests the combination of feed water measurement, indicator diagrams, and steam meter affords a triple check which must add greatly to the reliability of the results. There is little doubt that the advances which have been made in steam economy are largely due to the more accurate knowledge of performance which improved instruments have made possible. The indicator has been followed by the recording gauge, the pyrometer, the gas analysis apparatus, and the calorimeter, and the steam meter is a welcome addition to the list.

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**The Internal Friction of Lubricants.**

LUBRICANTS are generally supposed to act by forming thin layers of a viscous medium between the two surfaces, the rubbing friction of which it is desired to reduce, and there is no doubt that in general this is the action which takes place. The behaviour of the particles of the lubricant, acting upon each other, however, has not been so generally considered, and hence the investigations of Professor Petroff are of interest and value. Professor Petroff's paper, treating of what he calls "intermediate friction," was presented before the Imperial Academy of Sciences of St. Petersburg, by which it was awarded the Lomonossow prize, and has been published in the *Bulletin* of the Academy.

The variations in the lubricating efficiency of various oils are well-known, and carefully conducted experiments of Professor Petroff confirm the conclusions of other investigators that the value of a lubricant cannot be determined from its density, its temperatures of inflammation and congelation, its transparency, or its general appearance. Under these circumstances it has been sought to determine the causes for these variations in lubricating action, and hence Professor Petroff has made a study of the internal friction of the particles of the film of lubricant upon each other. That such an internal friction exists appears from the fact that when one surface slides upon another the force of friction is more or less completely transferred through the film of lubricant from one surface to the other, and, as the film does not move entirely with either surface, an internal motion of its particles must be produced.

The problem really becomes one of hydrodynamics, and demands the solution of the question of the relation between the two forces of external friction between the rubbing surfaces and the internal friction in the particles of the lubricant. In order to determine the data necessary for the solution of the problem, Professor Petroff has made many experiments, of which he gives the tabulated results in his paper.

The theoretical examination of the problem leads to the rather unexpected conclusion that the internal friction is independent of the velocity of the rubbing surfaces and of the density of the lubricant. The experiments made to verify this theoretical conclusion are given in detail in Professor Petroff's paper, the results of more than 600 experiments being tabulated and plotted as curves, the results not only confirming the theoretical deductions, but also serving to determine the numerical value of constants for a great number of different lubricants. The result of the investigations showed that each lubricant possesses what may be called a characteristic curve, and an examination of these curves enables the relative internal friction to be compared.

The apparatus used in the experiments of Professor Petroff consisted practically of a form of brake, in which the revolving journal was clamped between two boxes, the boxes and clamp forming a sort of pendulum carried upon the journal. When the journal was revolved, the weighted pendulum assumed an angular position, in which the moment of the whole mass opposed the friction of the journal and boxes, this friction being transmitted through the film of lubricant upon the bearing, and measured by the angle of deflection of the pendulum. A recording device enabled this deflection to be indicated upon a travelling strip of paper moved proportionally to the speed of revolution of the journal, devices being provided to enable the temperature of the bearing and of the surrounding air to be taken. A modified form of this apparatus was constructed to receive the standard railway axle and bearings, so that lubricants intended for railway service could be examined under conditions similar to those of actual use.

The above described apparatus gives the total friction, the energy thus absorbed reappearing in heat in a manner which can be conveniently measured. The internal friction in the lubricant is determined separately by means of a device in which the oil is forced, under a known pressure, through a long tube of fine bore, the time required to deliver a given volume of oil through the tube being the measure of its viscosity. The characteristic curve of each lubricant is plotted, using the temperatures as abscissas, and the viscosities as ordinates, and in connection with the records of total friction they render it possible to select the best lubricant for any given service.

The method of investigating lubricants according to this method consists in drawing the characteristic curves of the various oils from which choice may be made. The mean temperature of the surrounding air is then taken, as well as that of the bearing film for any one of the lubricants. The point is then taken on the characteristic curve corresponding to the temperature of the bearing, and also the point on the axis of temperatures corresponding to the temperature of the surrounding air. A straight line is then drawn through these two points, and the ordinates of the intersections of this line, with the characteristic curves, give the relative values of the forces of friction for the respective oils. The cost of the power required to overcome these resistances are proportional to the respective forces, and these may then be compared with the cost of the corresponding lubricants.

The importance of the consideration of the viscosity of lubricants has been discussed before the appearance of the paper of Professor Petroff, but his exhaustive discussion of the whole subject is a most valuable contribution to the literature of power transmission, and is well worthy the examination of engineers who have realised the importance of intelligent lubrication as a means of diminishing friction losses.

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**The Steam Turbine.**

THE report of the tests made at Elberfeld by Messrs. Lindley, Schröter, and Weber, upon the Parsons steam turbine, has already been reviewed at length in these columns (September, 1900,) and this report has now been translated into French, and published in the *Revue de Mécanique*. This translation is followed by a discussion from the pen of M. Rateau, whose ability and experience in this especial branch of work is well known.

M. Rateau calls attention to the high efficiency of the alternator operated by the Parsons turbine, and attributes this to the great peripheral speed of the inductor, which in this case attains 60 metres per second, or about double that usually found. The attainment of this high speed is a direct result of the use of the steam turbine as a motive power, and is an additional argument in favor of the steam turbine, over and above any general advantages which it may have as a motor. Apart from the diminished proportional reaction of the inductor at higher speeds there is also the increased steadiness of rotation due to the fact that the kinetic energy of the revolving member increases with the square of the velocity, while the power increases directly as the speed, so that the fly-wheel action increases with the speed.

The high economy shown by the Parsons turbine tested at Elberfeld bears witness not only to the efficiency of the machine,

but also to the excellence of the vacuum. The steam consumption, at 1,200 kilowatts, of 19.4 pounds per kilowatt-hour, corresponding to about 14.5 pounds per electrical h. p. hour, is equal to that of the best triple-expansion engines, leaving in this respect no reason for preferring the latter machine.

M. Rateau takes the data from the Elberfeld report, and proceeds to compute the theoretical steam consumption corresponding to an efficiency of 100 per cent., and shows that with a load of 1,200 kilowatts the actual efficiency was 58 per cent., a most excellent result. In his report at the recent Congrès de Mécanique, at Paris, M. Rateau showed that it was not difficult to obtain an efficiency of 64 per cent. with the steam turbine, and taking the efficiency of the alternator at 94 per cent., a figure which should undoubtedly be attained, an efficiency of $0.64 \times 0.94 = 0.60$ is secured for the combination, which agrees very closely with that experimentally obtained in the Elberfeld trials.

Recent experiments at the Sautter-Harlé establishment have demonstrated that it is possible to obtain, with steam turbines of 2,500 to 3,000 h. p., an efficiency of 70 per cent. for the turbine alone. The steam consumption, with an admission pressure of 114 pounds per square inch absolute and an exhaust pressure of about 0.9 pounds absolute, and a superheat of 20° C., would then fall to 17.1 pounds per kilowatt-hour, corresponding to 12.75 pounds per electrical h. p. hour, an efficiency which has as yet not been attained by any piston engine.

When it is considered that the whole line along which advance in steam engineering must be made involves high speeds, and electrical transmission and distribution of energy, it certainly appears that the steam turbine must be the coming form of steam motor. Engineers have sought for a successful rotary engine for more than a century, realizing that the inherent defects of the reciprocating engine formed a bar to improvement. All rotary engines, however, possessed far greater defects than the form which they sought to replace, and were especially wasteful of steam. In the steam turbine, however, we have the entire elimination of reciprocating parts, the predominance of the speed element of power generation, carrying with it reduction in weight and steadiness of motion, and, finally, a steam economy higher than that of any piston engine yet constructed. With these advantages are included the adaptability for direct connection wth electrical generators of a most desirable and efficient type, the whole forming an ideal combination for the generation of power from coal and its distribution in the form of electricity. Unless some corresponding improvement is made to enable the reciprocating engine to maintain its present commanding position, it seems reasonable to assume that the steam engine of the future will be of the high-speed, rotary type, based upon some one of the present forms of steam turbine.

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**The Phase Theory of Iron and Steel.**

UNTIL within the past few years the knowledge of the real conditions which exist in the various forms of iron and steel was very vague, and the theories contradictory, but in very recent years the researches of a few scientists have brought some measure of order out of the chaos, and the study of iron and its combinations may fairly be said to have entered upon a new period. The whole period of investigation and research upon which the modern ideas rest is well covered by an important paper translated from the German of Professor H. W. Bakhuis Roozeboom by M. F. Osmond, and published, with full comments, by MM. Osmond and Le Chatelier, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.*

In 1896, Baron Jüptner von Jonstorff called attention to the necessity for gathering the observed and hitherto contradictory facts into some sort of orderly system, and early in the following year appeared the masterly paper of M. Le Chatelier upon the existing condition of the theories of the tempering of steel. Le Chatelier then enunciated the theory that the alloys of iron and carbon, known as steel, were in reality solid solutions, which during cooling were capable, in a manner similar to liquid solutions, of depositing either simple or compound bodies, or both. Le Chatelier also showed that these trans-

formations were closely connected with the allotropic transformation of the iron itself, a fact which had already been suspected by Osmond. The fourth report of Professor Roberts-Austen to the Alloys Committee of the Institution of Mechanical Engineers appeared about the same time, treating the subject in a similar manner, and gathering the observations in the form of a graphical diagram representing the phenomena of solidification and those of the transformation into a solid mass. This was the first attempt to give a complete view of the relations between iron and carbon.

In 1898 appeared further communications from Baron Jüptner, discussing the "solution theory" of iron and steel, followed by the researches of the author, Professor Bakhuis Roozeboom, the fifth report of Sir Roberts-Austen, and the work of Stansfield. These later researches have furnished data enabling more complete diagrams to be formed, and in discussing these Professor Bakhuis Roozeboom enunciated the so-called "phase theory" as applied especially to the phenomena of solidification.

The very full discussion of Professor Bakhuis Roozeboom takes up the behaviour of mixtures containing various percentages of carbon, showing in each case how the proportion of carbon present affects the behaviour at various temperatures. For the details the reader must be referred to the original paper, but some of the conclusions may be given here, and the practical value of the researches shown.

The general conclusions may be summed up as follows:

Cast alloys containing from 0 to 2 per cent. of carbon, solidify in crystals of a homogeneous mixture in which the iron is in the so-called gamma state, that is, stable above 890°; this combination being called martensite. Cast alloys containing from 2 to 4.3 per cent. of carbon form, in solidifying, a skeleton of mixed crystals of which the intervals are filled with the eutectic alloy consisting of a conglomerate of mixed crystals and graphite containing 4.3 per cent. of carbon. By the eutectic alloy is meant the alloy which solidifies at the lowest possible temperature for the series under consideration. Cast alloys containing more than 4.3 per cent. of carbon form, in solidifying, a skeleton of crystals of graphite, of which the interstices are filled with the eutectic alloy.

Alloys containing more than 2 per cent. of carbon deposit their carbon at temperatures between 1,130° and 1,000°. At 1,000° there occurs a transformation which produces the carbide of iron known as cementite, at the expense of the martensite and the graphite. When the total carbon content is less than 6.6 per cent. there is thus obtained a conglomerate of martensite and cementite. This transformation is the first example in which a chemical combination (cementite) is formed of a solid solution (martensite), and one of its elements (graphite), and that at a temperature quite comparable with the temperature of the transformation at which combinations are produced in the liquid solution and one of its elements.

The formation of cementite advances progressively between 1,000° and 690°, the crystals of martensite in the conglomerate being impoverished in carbon down to 0.85 per cent. These crystals disappear altogether at 690°, decomposing into alpha iron, or ferrite (stable below 770°), and cementite.

When the normal order of events is not followed it is due to sudden cooling. The action in this case is difficult to determine, but it appears that cementite is immediately formed, and that, from the instant that cementite is formed from the martensite and the graphite, a portion of the latter escapes entirely the transformation.

Alloys containing from 2 to 0.85 per cent. of carbon may, during the period between 1,000° and 690°, allow the cementite to separate, and, at 690°, to be decomposed into cementite and ferrite; but these two transformations may be checked by rapid cooling, the mixed crystals then being retained as martensite.

Alloys containing from 0 to 0.35 per cent. of carbon show a gradual separation of beta iron between 890° and 770°, and then, at 770° a total transformation of the beta into alpha iron, followed by a gradual separation of the alpha iron, the mixed crystals remaining at 770°. Alloys containing 0 to 0.85 per cent. of carbon only show a separation of alpha iron between

770° and 690°. In all the alloys from 0 to 0.85 per cent. of carbon, the transformation of the mixed crystals of martensite existing in ferrite and cementite is produced at 690°. The conglomerate of these last two (perlite) contains 0.85 per cent. of carbon. The transformation of the mixed crystals containing from 0 to 0.85 per cent. of carbon like those of the alloys containing from 0.85 to 2 per cent., may be suppressed by a sufficiently rapid cooling from the higher temperature to the point of transformation, this constituting what is commonly known as tempering.

The description of the transformations of the mixed crystals containing from 0 to 0.85 per cent of carbon may be slightly modified if it is admitted that both the alpha and beta forms of iron are capable of dissolving small quantities of carbon, and this supposition is not contradictory to any observed facts.

The alloy known as austenite, like martensite, may be compared to mixed crystals separating from a concentrated liquid solution, and may exist by the side of martensite and cementite, being transformed by slow cooling into a conglomerate of the two latter.

The comments of MM. Osmond and Le Chatelier upon the exhaustive paper of Professor Roozeboom confirm in nearly every point the correctness of his judgment in the readings drawn from experiment.

### The Progress of the Siberian Railway.

In view of the activity in China of European interests and the influence which is produced thereby upon everything relating to communication with that part of the world, the progress of the trans-Siberian railway is a question of very present interest. Two recent papers before the Société des Ingénieurs Civils de France bear upon this subject; one, by M. Platon Yankowsky, upon the crossing of Lake Baikal, and the other a review, by M. A. Jacquin, of the communication of M. Ziffer to the Austrian Society of Engineers upon the railways of Siberia in general. To these may be added an article by Herr F. Theiss, in a recent issue of *Glaser's Annalen*, upon the Manchurian railway, and the importance of Port Arthur considered as a Russian naval station.

The crossing of Lake Baikal, with which M. Yankowsky deals, is a peculiarly difficult problem, since it involves the transport of trains by ferry, through heavy ice, over a rough body of water for a distance of about 40 miles.

It is ultimately intended to replace this lake crossing by an all rail route around the end of the lake, and two routes have been surveyed for this extension. One of these is about 85 miles long, and the other 190 miles; the longer route, which will probably be adopted, making a circuit to follow the Irkout river, and involving a tunnel more than two miles long, piercing the Zyrkouzoune range. This section of the railway will probably not be completed until 1903, and with the still uncompleted Manchurian section, must be finished before the complete railway across Asia is an accomplished fact. In the meantime the Lake Baikal ferry will continue to be used, and even after the section around the lake is completed the ferry will probably be maintained for some trains, because of the shorter distance.

The necessity for using powerful ice-breaking boats, having a draught of 20 feet of water, required the construction of landing piers extending out into the lake to deep water. The pier connected with the western section of the railway, at the Lake Baikal station, is 1,800 feet in length, and that at Missovaia, on the other side of the lake, is 1,200 feet long. These piers are constructed of wooden caissons, filled with stone, each being made in the form of a fork, with two branches of unequal length. The longer branch of the Y extends out into the lake, and the shorter branch extends along the shore, the ferry boat entering into the protected space between. A special form of hinged bridge enables the varying height of water to be provided for in running the trains upon the ferry boats. Powerful electric lights, forming light-houses of the sixth order, are erected upon the moles in order to guide to the entrance.

The chief interest, however, is centered in the boat "Baikal," a powerful ice breaker, constructed partly upon the plans of the American ice-breaking ferry boats, "St. Marie" and "St. Ignace," used on Lake Michigan, and partly on the model of

Nansen's polar ship, "The Fram." The "Baikal" is 290 feet long, by 57 feet beam amidships, and 26½ feet deep, with a forward draught of 20 feet. The total displacement, including 580 tons of water-ballast and 250 tons of coal, is 4,200 tons. There are three propelling screws, two in the stern and one at the bow, these being driven by three triple expansion engines of 1,250 h. p. each. The two stern propellers enable a speed of 12½ knots to be maintained in smooth water, while the three screws drive the boat easily through solid ice 3½ feet thick at a speed of about 3 knots. The "Baikal," as an icebreaker, is second only in power to the "Ermak," constructed by Vice-Admiral Makaroff for the winter service in the Baltic.

M. Yankowsky's paper gives interesting details about the construction of the piers and connections, as well as data concerning the operation of the ferry service.

The general review of the Siberian railways, by M. Jacquin, is devoted mainly to the trans-Siberian railway, which is treated in its several sections, giving details of character and construction of each portion, and of the population and nature of the territory. There are also given valuable data concerning projected railways, of which the greater number form branches of the main Siberian line.

Including the various branches of the Siberian system, from the western section, starting at Tcheliabinsk, and opened in 1896, to the last portion of the Eastern Railway of China, the Manchurian section of the Siberian railway, to be completed in 1906, the railways of Siberia foot up a total of 7,639 kilometres, or 4,740 miles, at a total cost of 982,116,250 francs, or 128,566 francs per kilometre.

The great effort of Russia, ever since the days of Peter the Great, has been to obtain a naval station in waters open and free from ice the whole year 'round. In Europe both Cronstadt and Archangel are closed in winter, while the outlet of the Black Sea is in the control of other powers. Vladivostock, the original port selected as the terminus for the Siberian railway, is closed for several months in each year, while Port Arthur, situated most advantageously on a peninsula on the Yellow Sea between Corea and the main coast of China, has only a thin sheet of ice on the inner bay for two or three weeks in winter, and the main roadstead is entirely free from ice at all times. It was to secure this coveted port which led to the negotiations by which the Russian government acquired the privileges of diverting the eastern section of the railway through Manchuria, and although the nominal terminus is still at Vladivostock, the spur of railway, leaving the main line at Hulan and running southward to Port Arthur, is practically a division of the main line, and destined to become most important.

The entrance into the bay of Port Arthur is about ¼ mile wide, and a little more than ½ mile long, the main, or western harbour being separated from the outer roadstead by a hilly peninsula, called, from its form, the "Tiger's Tail." The so-called eastern harbour is really an artificial basin, formed by deepening and enclosing a fresh water lake, and is about 1,600 feet long by 1,000 feet wide, and capable of receiving the largest battle-ships. This basin is about 32 feet in depth, and is enclosed by granite sea-walls, upon which are mounted numerous cranes and electric-lighting standards. The harbour is surrounded with warehouses, machine shops, and other buildings, and there are two docks, one large one for warships, and a smaller one, adapted for torpedo boats, destroyers, etc. On the peninsula, which separates the western harbour from the outer bay, is the location for the torpedo arsenal, and a small drydock for the reception of torpedo-boats. Here are also numerous work-shops, a training school for mechanics, and vaults for the storage of explosives. The town itself, with a population of about 50,000, lies to the north of the western harbour.

The fortifications of Port Arthur, which were originally designed according to the plans of Hannecken, were carried out later by English and French engineers, and these works have since been extended by Russian engineers so thoroughly that the place is now undoubtedly a fortress of the first rank. The fortifications on the hills on the sea side of the town include a number of forts fully equipped with Krupp rapid-fire guns. During the past year the Russian government has spent upon harbour improvements, including docks, workshops, floating cranes, barracks, etc., about 11,000,000 roubles.

# REVIEW OF THE AMERICAN PRESS

### Transcontinental Triangulation.

THE completion of the geodetical connection between the Atlantic and Pacific coasts of the United States marks an important step in the completion of the measurement of the earth, and an interesting résumé of the work is given by Mr. John E. McGrath, assistant in the U. S. Coast and Geodetic Survey, in a recent issue of *Engineering News*.

The measurement of the Transcontinental Triangulation was directed by Congress by the Act of March 3, 1871, providing "for extending the triangulation of the Coast Survey so as to form a geodetic connection between the Atlantic and Pacific coasts of the United States." At that time the geodetic data available for incorporation in the proposed arc comprised the results from the measurement of the Kent Island base, the angles at 13 stations of the triangulation along the Atlantic Coast, 7 azimuths observed in connection with the same triangulation and 19 latitudes. The completed arc depends upon ten bases; horizontal angle observations at 308 primary and 240 secondary stations; an unbroken line of precise levels from Sandy Hook, New Jersey, to Rock Creek, Wyoming, supplemented by vertical angle measures which complete the hypsometric connection from ocean to ocean; 109 latitude stations, 73 azimuth stations, and observed differences of longitudes at 37 stations.

The measurements of the various bases form a most interesting feature of the work, representing, as they do, a variety of methods and apparatus, and confirming, in a most satisfactory manner, the accuracy of the entire system of triangulation.

The measurements at the Holton and St. Albans bases produced results of great interest to the geodesist and engineer. At Holton, Ind., the Woodward steel bar-in-ice was first used for the measurement of a standard hectometer and kilometer section, and its successful operation proved that it solved the problem of supplying a practicable form of field apparatus from which the varying temperature effects, the chief source of error in all high-class metrology, were eliminated; here also was put to a satisfactory test a modification of Jaderin's method for the use of metallic tapes for geodetic base work. At St. Albans, West Virginia, is the first base of the triangulation measured exclusively with a steel tape. The standardizing section for securing the length of the tape was 100 meters in length, and was determined with a 5-meter bar-in-ice. The length of the base was 2.4 miles, very nearly; the probable error of the base due to uncertainty in length of tape was 0.09 inch; the probable error due to measurement was 0.09 inch, and the quantity due to uncertainty in reduction to sea level was 0.04 inch; resulting probable error for base reduced to sea level is 0.14 inch, or about 1-17 inch per mile.

A large variety of instruments were used in the angular work, but it can be broadly stated that in the large figures west of Pike's Peak the 20-inch direction theodolites were employed; that in the region between the Rocky Mountains and the Alleghenies 12-inch theodolites were used; in the Alleghenies the work was executed with 20-inch theodolites; in the Blue Ridge a 30-inch instrument was used at some of the old stations, and 20-inch theodolites at the recent ones; the work about the east end of the arc was executed with 12 or 24-inch instruments.

The eastern portion of the work covered a country not greatly different from that found in many other parts of the world, but the western portion of the United States offered peculiar conditions.

"The tremendous range of a triangulation crossing the continent from ocean to ocean developed conditions which necessitated the application of every refinement known to geodesy in the reduction of the operations,

while the execution of the field work made it imperative upon the observers to devise means for overcoming difficulties that at times seemed insuperable. From California to Colorado the arc advances in the largest consecutive series of polygons in the world; 20 of the lines are over 100 miles in length and one line of sight, from Mt. Uncompahgre to Mt. Ellen, is 182.7 miles in length. In this section signals of wood or stone, aside from their expense, were inadmissible because of the atmospheric conditions which affect the visibility even of the great mountain tops. On the long lines occurring there, the observations were made upon heliotropes, simple and cheap in construction, requiring only the attention of a class of service that could be secured anywhere, and which shone with the brightness of a first-magnitude star through haze and vapor that often made the mountain tops indefinable.

"The value of the length of the arc of the 39th parallel, which is now completed and available for use in the determination of the earth's figure, is 4,224,010 metres. Its astronomical amplitude is 48° 16′ 47″.83, and the geodetic amplitude is 48° 16′ 39″.57. The probable error of the length value is 26 meters. Computing the value of a similar arc from the elements of Clarke's and Bessel's spheroid, the results differ by 615 metres. The high measure of accuracy of the length of the American arc, and the fact that it lies intermediate between corresponding values deduced from the Clarke and Bessel figures, seems to indicate that only very small changes will ever have to be made in its standard geographical positions because of reference of the work to a more truly representative figure of development."

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**Pneumatic Appliances in the Foundry.**

It has generally been assumed that the foundry is the least modern portion of the machine works, and that improved methods and appliances are less in evidence there than in the tool room and machine shop.

Formerly this was undoubtedly the case, but the rapid introduction of traveling cranes, moulding machines and pneumatic tools has done much to redeem the foundry from the reproach of neglect, which was formerly too often merited.

The use of compressed air especially has aided in facilitating foundry work, and the share which is due to pneumatic tools in the advancement of foundry work is well shown in a paper by Mr. W. P. Pressinger in a recent issue of the *Journal* of the American Foundrymen's Association.

"The introduction of pneumatic tools in a form marketably perfected for shop or foundry usage dates back but a few years, and their wide-spread adoption, remarkable for its rapidity, is, after all, the most convincing proof of their commercial value. Today a boiler shop or machine shop devoid of compressed air equipment is a rarity, and if the foundry end of our mechanical community is not so well provided for, I venture to say that it is because the merits and labor-saving properties of pneumatic machinery have not, in the rapid development of the business, been as thoroughly demonstrated to the foundry trade. The day is near at hand, however, when a foundry without pneumatic equipment cannot produce its output in commercial competition with foundries that have adopted it."

One of the earliest and most widely employed of foundry appliances actuated by compressed air is the pneumatic hoist, used both in the straight lift and in the horizontal forms. Air hoists are especially adapted for foundry work, because of the smooth, even motion, so desirable in lifting copes and moulds, and also because of the impossibility of a sudden drop in handling vessels of molten metal.

The pneumatic hammer, in some one of its many forms, has to a great extent done away with the laborious work of chipping castings by hand. The extent to which this most useful tool has extended the range and capacity of the chipper's work is hardly appreciated except by those who have had actual experience and observation, but it has done much to diminish the heavy labor in the foundry, and incidentally to minimize the effect of labor troubles.

Pneumatic sand rammers, air drills, moulding machines, tumbling barrels, etc., are among the many applications of compressed air in the foundry. In addition to these is the sand blast, a most efficient appliance, not used as much as it should be. When it is considered that one man operating a sand blast apparatus, consuming 120 cubic feet of air per minute, can clean more

surface and remove more cores in a given time than is possible for six to ten men to do with hammers, chisels and brushes, apart from the superior character of the work, the possibilities of the apparatus are evident.

"There are, of course, numerous special employments of compressed air in foundry work peculiarly adaptable to individual conditions, but not of general interest or application, but such applications suggest the inevitable conclusion than when once compressed air is available, the number of convenient and economical possibilities that it presents to the progressive operator is surprising, and its field of usefulness broadens with amazing, but none the less gratifying, rapidity. Second only to electricity in its fascinating possibilities, compressed air yields nothing to electricity as a power with properties peculiarly its own, inimitable and unsurpassed in the commercial development of our time, and with the constantly rising standard of efficiency in air compressing machinery, that most important source of power which regulates the value of pneumatic appliances, more widespread adoption is inevitable. Imperfect and wasteful air compressors, possessing the primary virtue of cheapness, but with all the faults in the mechanical calendar, will do more to offset the resultant value to be derived from the use of pneumatic foundry equipment, than labor antagonism, either secret or expressed. Therefore, to derive the utmost benefits from the installation of compressed air machinery, the selection of a compressor should be carefully considered. It is unwise to install a compressor just about equal in capacity to present requirements, good practice being to provide a compressor at least 50 per cent. greater in capacity than immediate necessities demand. Compressors of the duplex type are divisible, permitting the installation and operation of one-half at first, and the other half when the additional capacity is needed. The theoretical capacity of an air compressor, stated in the list of the maker, is not the equivalent of the actual volume of air needed for the service. All makers list their compressors according to theoretical measurement, but the efficiency of the compressor is determined by the volume of air actually delivered with a given consumption of power. The cheap air compressor usually proves the most expensive. If a water pump fails in its work, or if a steam engine is deficient, the shortcomings are self-evident, but if an air compressor is poorly designed or badly constructed, it may continue in the evil of its ways until the scrap heap claims it for its own; unless, as is more likely, an absolute breakdown calls attention to its deficiencies and shows, all too late, that the hole it has made in the coal pile, added to the cost of keeping it in repair, would have paid a handsome interest on the additional first cost of a properly designed and properly constructed compressor."

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**Compressed Air Traction in New York.**

ALTHOUGH electric traction is undoubtedly the best motive power for tramway service in a great city, especially with the underground trolley system so successfully used in New York and elsewhere, compressed air furnishes a most useful auxiliary. The peculiar shape of New York City renders it extremely desirable that some convenient system for the shorter cross lines, running east and west, should be used to supplement the long north and south electric lines.

An interesting account of the compressed air system used in New York is given in a recent issue of *Compressed Air*, from which we quote:

"The most interesting installation probably ever yet made of motor cars operated by compressed air is that of the Twenty-eighth and Twenty-ninth street cross-town line of the Metropolitan Street Railway Company of New York. It is interesting, especially in the fact that it is a complete installation, no other cars being operated upon the line either night or day but the compressed air cars. In this plant, as elsewhere in compressed air trials, it would seem that the best conditions were not at the first insisted upon. Indeed some mistakes were evidently made. The tracks of this line were cheaply and hastily laid some ten years ago for the light horse cars of that time, with no thought of any heavier traffic, and the track had not been maintained in proper condition, and upon this track the air cars were started. The tracks have since been relaid, and are now in fair condition for the service. It was a rash

and risky thing to do to start a permanent service of this responsible character with a single unit of supply at the power house. However perfect and adequate the apparatus, there are too many possibilities of accident or derangement for the risk to be taken. The compressor in use is also of much larger capacity that the present service requires, it having been designed in contemplation of partially supplying a much more extensive service, which it was hoped would be and is now confidently expected, will be developed. The compressor is easily capable of supplying three times the number of cars now in service, or three times each day the business of that which it at present supplies. The compressor is now run at 27 revolutions per minute, when it might be run at 75 revolutions. No larger force of men, of course, would be required for the increased speed, although a few more men would be required in the car shed."

A tabular statement of performance since September, 1900, shows that with an average of 17 cars running, making round trips of 5.5 miles and a car mileage per day of 94.6 miles, the total cost for all expenses of motive power was 8.31 cents per car mile. The other operating expenses, such as conductors, motormen, roadbed, salaries, etc., etc., was 9.11 cents, making a complete total of 17.42 cents per car mile.

"The above computation is made on a basis of 1,750 miles per day, and although every charge is made for the present operating of only 20 cars, yet from 60 to 80 cars could be operated by the charging and power plant without any material increase in cost, so that for a more extensive installation the cost of operating would be materially reduced.

"The report of the Metropolitan Street Railway Company for the year ending June 30, 1900, gives the relative and actual costs of operating cable, electric and horse railroads. For horse cars the average was 18.98 cents per car mile, the cars being much smaller than those of the other systems; for cable cars, 17.76 cents, and for electric cars, 13.16 cents. The figures were made to include all expenses of operation and maintenance. The estimate given may be assumed to show very nearly the best attainable results by either of the systems at present. The figures given in the computations relating to the air cars evidently do not give the best results, as the conditions are far from being the best that can be secured with our present knowledge. The compressor, as was stated, is very much too large for the present service and works at a constant loss. The plant has all the disadvantages of a new plant in the inexperience and lack of trained judgment of the men employed. It is to be noted that the expenses for repairs, two cents per car mile, are even now remarkably low for any system except the horse-car."

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**The Parsons Steam Turbine in America.**

ALTHOUGH the Parsons steam turbine has been applied to a variety of uses in England and on the Continent, the most notable applications of it which have been made by Mr. Parsons himself have been in connection with steam navigation. In America, however, probably from the fact that its manufacture is in the hands of the Westinghouse Company, it has mainly been developed in connection with the driving of electric generators. For this reason the paper of Mr. Francis Hodgkinson, recently presented before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the Society, is of peculiar interest.

After reviewing the early conceptions of Hero and of Branca, Mr. Hodgkinson discusses the theoretical forms of nozzles best adapted to produce the proper discharge for turbines of the de Laval type, and then proceeds to describe the Parsons turbine, the general form of which is so well known as to render any very detailed description here unnecessary.

Some interesting information is given in the paper concerning the governing of the turbine. A centrifugal governor is used, the position of the balls acting to control the intermittent admission of the steam. An admission valve is operated mechanically, admitting the steam in puffs, which occur at constant intervals of time. The puffs are of long or short duration, according to the load, and at full load they merge into an almost continuous blast. These puffs have nothing to do with the expansion of the steam, which is taken care of independently at all times by the blades of the turbine.

"The advantages of this intermittance are three-fold. The turbine is at all times using boiler pressure steam, no matter what the load may be. The admission valve is continuously in motion, and consequently gets no opportunity to get stuck. The power to work the relay valve and overcome the inertia of the levers is transmitted through the governor clutch, hence the balls are moved in and out a very small amount at every oscillation of the levers, so that the governor levers in respect to their motion about their points of suspension are never at rest, and consequently when a change of load comes, the governor does not have to overcome the friction at rest, and is always ready to go to its new position."

Theoretically considered, the steam turbine should be the most efficient form of mechanism for the conversion of heat into mechanical energy by the medium of steam.

"A jet of steam issuing through a properly constructed orifice has as much energy as the same steam performing high ratios of expansion behind a piston. In both cases the work to be theoretically abstracted from a given weight is the same. However, there are some practical reasons for expecting better results in the case of the turbine.

"In the design of a three or four stage compound condensing reciprocating engine, it is found that there is no gain in economy by expanding the steam in the low pressure cylinder beyond a terminal pressure of about 5 or 6 lbs. absolute. To do so means very much increasing the volume of the low pressure cylinder, thus increasing the friction of the engine and the weight of reciprocating parts. Moreover, the temperature of saturated steam, as these low pressures are reached, falls off much more rapidly; hence there are greater losses, due to condensation and re-evaporation, than would be gained by a more complete expansion. In the steam turbine, no such limits exist. The extra volume of the low pressure end does not add to the friction. The temperature conditions from end to end remain always the same, and hence such losses as condensation and re-evaporation are not in evidence.

"Turbines are constructed to utilize the energy of the steam down to the utmost limits. A condensing steam turbine, when in operation, affords a striking example of the conversion of heat into energy. The temperature of the walls of the cylinder at the high pressure end, about 365° F., falls in the distance of three or four feet to a temperature of about 126° at the low pressure end."

Mr. Hodgkinson gives data from tests made upon a 300 kilowatt turbine at the Westinghouse Air Brake Company's works, in which it is shown that with a boiler pressure of 125 pounds per square inch, and a vacuum of 26 to 27 inches of mercury, at 3,600 revolutions per minute, the steam consumption was 16.4 pounds per *electrical* horse-power-hour at full load, rising only to 22 pounds at one-fourth load.

At the high speeds employed with steam turbines especial care must be taken in balancing the rotating parts, and the paper gives some interesting information about the methods of securing a true running balance. These are not greatly different from those which have long obtained in the construction of high-speed woodworking machinery, but their application to steam machinery is of comparatively recent date.

The especial applicability of the Parsons turbine for driving alternators in multiple lies in the fact that the angular velocity of the machine is practically uniform at all points in every revolution, a condition not readily attainable in reciprocating engines. Crank engines, to be adapted to this class of work, must be designed with this especial end in view, and especially liberal proportions given to the fly wheel, together with proper governor adjustment, while with the turbine the uniformity of rotation is an inherent feature in the construction.

It is interesting to note that in the course of the discussion upon Mr. Hodgkinson's paper it appeared that the cost of a steam-turbine generator is such that it can be sold at the same price as a regular Westinghouse compound engine and generator outfit.

### Electric Power in Workshops.

At a recent joint meeting of the mechanical and electrical sections of the Franklin Institute there was recently held a very interesting discussion upon the subject of the electrical distribution of power in workshops, which revealed to a remarkable degree the extent to which electrical driving has already found favor.

From the report of the discussion in the *Journal* of the Franklin Institute some points may be taken, showing the general trend of opinion.

Professor F. B. Crocker, of New York, called attention to the fact that this new combination of the electrical and mechanical branches of engineering is not much more than five years old, and yet its introduction and success have been so general that it promises to be adopted almost universally in the next five or ten years.

Professor Crocker enumerated serially the advantages of electrical driving very fully, showing that there is a material saving of power by its use, although this is not the most important advantage, since the power-cost is only about 3 per cent. of the total expense. The absence of heavy overhead shafting enables a considerable economy of the cost of buildings to be made, and this is a matter of importance when new buildings are being planned. The first cost of the electrical equipment is slightly greater than that of shafting and belting, but the depreciation can be made much less, as can the cost for lubrication.

A great advantage in electrical driving is the freedom which it permits in the arrangement of machinery. The location and direction of shafting need no longer be considered, and the machines may be placed in the best position for operation, there being no necessity for placing them in rows, or placed at any particular angle with respect to each other. The advantage of clear head-room is also great, and comparison between the old methed and the new in actual service is all that is needed to emphasize this advantage. Electrical machinery is much cleaner than overhead shafting, and this alone has an important influence upon the health of employees. As an example it may be noted that in the Government Printing Office, at Washington, the sick list decreased 20 to 40 per cent. after electric motors were introduced.

An important advantage of electrical driving lies in the transmission of power to detached buildings, and in the enlargement and extension of plants the buildings, like the machinery within them, can be located for general convenience, and not with special regard to supplying them with power.

A most practical example of the advantages following the introduction of electrical driving for machine tools is found in the case of the Baldwin Locomotive Works, at Philadelphia. According to the statements of Mr. Samuel M. Vauclain, the superintendent of the works, the advantages seen in the operation of electrically operated traveling cranes led them to extend the system to many of their machine tools. The advantages reside both in saving of floor space and in operating expenses, as appear from the statement that the abandonment of electrical driving would cause an increase of 20 to 25 per cent. in the cost of the manufactured product for labor alone, while if it were not for electric driving the Baldwin works would have to cover 40 per cent. more floor space than they now do to maintain their present output.

Mr. G. S. Dunn referred especially to the speed regulation of the electric motor, and showed the methods of effecting the important function of speed control, comparing the method of control by resistance with that by variation of voltage. He also referred to the system of providing for the establishment throughout the shop of multiple voltage circuits, maintaining permanently six or more fixed voltages of different values, to any one of which the motor may be connected at will.

The results of the introduction of electric driving at the Government Printing Office, at Washington, confirm fully those cited from the Baldwin Locomotive Works. Here a plant costing $50,000 showed a total gain of 16 2/3 per cent. on the investment, which, less 6 2/3 per cent. for insurance, taxes and interest, gives a clear gain of 10 per cent. on the expenditures for coal and gas alone.

The ability to rearrange machinery irrespective of line shafting made all space equally available, and permitted the addition of forty printing presses, thus increasing the working floor space without requiring increase of actual floor area. It was estimated that the increase in production in the presses was at least 10 per cent., and the average earning capacity being $10 per day, the net gain was sufficient to pay for the entire plant in five years.

The most important outcome of the discussion was the emphasis laid upon the fact that the indirect gains due to electric

driving are far greater than the mere power economy. In many cases, undoubtedly, electric driving has been examined and rejected solely upon the moderate economy showing presented. The data as to labor economy, increased efficiency of floor space, advantages in the arrangement of machinery, and increased output, are now so clearly shown as to place the whole question on a far higher and broader plane, and the result will certainly be as great a transformation in machine driving during the next ten years as has been experienced in tramway traction during the decade just closed.

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**Water Filtration at Pittsburg.**

WATER filtration is undoubtedly destined ultimately to form an essential question for every large city, and for this reason the paper of Mr. Morris Knowles, in the *Journal* of the Association of Engineering Societies, upon the experimental filtration plant at Pittsburg, will doubtless be read with interest for the definite information which it furnishes.

This experimental plant is the outcome of the appointment of a special commission by the City Council for the purpose of investigating the subject with regard to the proposed construction of a plant for Pittsburg, Mr. Allen Hazen, of New York, being the consulting engineer for the commission. Since 1897 experiments have been conducted with sand filters, mechanical filters, and tile filters, and Mr. Knowles' paper gives the results of the work, more fully detailed in the report of the commission.

The slow sand filter plant consisted of a settling basin of 38,800 gallons' capacity and two filter beds, each bed being 25 ft. 3 in. by 11 ft. in area, with a depth of sand, originally of 5 feet, ultimately diminishing to 4.2 feet.

The mechanical filters tested were those known as the Jewell and the Warren types, both using sulphate of alumina as a coagulant, and differing mainly in mechanical details; while the tile filter was that known as the Wormser.

So far as bacterial efficiency was concerned, the slow sand filter showed slightly higher results than the others, an average for the year 1899 showing that between 98 and 99 per cent. of the bacteria in the raw water were removed by filtration. The average for six months for the mechanical filters showed the Warren to have an efficiency of 98.25 per cent., and the Jewell 97.45 per cent. The tile filter also gave an efficiency of 97.40 per cent.

Under these circumstances there appears to be no doubt that water such as is available for use at Pittsburg can be made altogether satisfactory for domestic use, notwithstanding the fact that the Allegheny river, from which by far the greater portion of the supply is derived, is often very muddy and is polluted by sewage from many cities, towns, and mining villages, together with considerable mine drainage at times.

The use of water for industrial purposes is an important consideration in Pittsburg, or, indeed, in any large manufacturing city. It was, therefore, considered advisable to learn what the effect would be of clarifying and filtering the Allegheny River water prior to its use in boilers.

Three new 25 H. P. boilers were kindly loaned by the Oil Well Supply Company for the purpose of an experiment in this line. Boiler No. 1 was supplied with the effluent from the sand filters, No. 2 with the effluent from the mechanical filters, and No. 3 with the unclarified river water. When these boilers had been in service for about two and one-half months they were blown off hot. Samples of scale were collected, and an examination was made of the interior of each.

The result of these tests showed that with the water from the sand filters the scale was composed of 53 per cent. of calcium carbonate, 13 per cent. of calcium sulphate, and 25 per cent. of magnesium carbonate. The water from the mechanical filters gave a scale containing only 27 per cent. of calcium carbonate, while the calcium sulphate rose to 53 per cent., and the magnesium carbonate fell to 12 per cent. With the raw river water 68 per cent. of the scale was composed of insoluble matter, and 16 per cent. of iron and aluminum oxides, the calcium salts being present in very small proportion.

It will be seen that the scale from boiler (No. 1), using the effluent from the sand filters, was composed largely of the carbonates of calcium and magnesium, which are not as troublesome as the sulphates. It was said that, by cooling down slowly, the for-

mation of this kind of scale could have been, in a measure, prevented. It will be noticed, however, that the scale from boiler (No. 2), using the effluent from the mechanical filters, was composed largely of sulphate of calcium, which is what would be expected from the chemical action caused by the addition of sulphate of alumina to the water. The scale upon boiler (No. 3), using the unclarified river water, was soft, and composed largely of mud and insoluble matter, material which could have been largely removed by judicious blowing out from time to time.

The statement of the practical boiler mechanic who examined the interiors after the experimental use, was that boiler No. 3 was in the best condition. This problem, however, must be considered as by no means settled by such a limited experiment.

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**The St. Croix Hydraulic Power Plant.**

THE development of natural sources of power and the transmission of the energy electrically to points where it can be made available, continues to advance in America, and a recent issue of the *Transactions* of the American Institute of Electrical Engineers contains an account of one of the latest additions to the list, being a description of the St. Croix power plant on the Apple River, in Wisconsin, by Henry Floy.

This plant is interesting for several reasons. The total amount of power available is not very great, there being a natural fall of about 30 feet, which was increased by a dam to a total head of 82 feet, and the minimum flow of the river is computed to furnish about 200 horse power, and during most of the year nearly twice that amount.

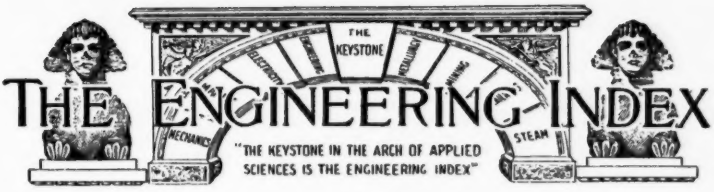
The plant has been designed to transmit current to St. Paul, a distance of 27 miles, for use by the St. Paul Gas Co., this plant permitting the shutting down of four existing steam stations and avoiding the necessity of building a modern steam plant and providing nearly twice the saleable output of the old stations.

The paper gives details of the construction of the dam, which is of arched form and 350 feet in length and 47 feet high. It is made with a masonry core, resting on concrete foundation and enclosed in concrete facings, and as completed is practically a concrete monolith.

The generating station contains four sets of turbines, each set consisting of two 36 inch Victor wheels, and there is room for a fifth set. Each pair of wheels is placed on a horizontal shaft extending through the wall and connected to a 750 kilowatt generator. The generators are three-phase, 800 volt, 60 cycle machines, running at 300 revolutions per minute, this pressure being transformed directly up to 25,000 volts for delivery to the line. There are two three-wire, three-phase transmission circuits, each consisting of 24½ miles of overhead bare copper wires, and three miles of underground cables connecting the generating station with the distributing station in St. Paul. The paper gives much detailed information about the 25,000 volt underground transmission, the ultimate success of this portion of the line being yet to show how it can stand the test of time.

The paper gives much interesting information about the transmission line, including the results of tests, the line having been successfully tested to a pressure of 30,400 volts, the general results of the tests being given with diagrams, showing the details.

The whole account is a valuable contribution to hydraulic, mechanical, and electrical engineering, showing, as it does, how a comparatively small stream at a distance from a large city may be harnessed and its energy transmitted, to the entire supersession of existing steam plants.




The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

# ARCHITECTURAL ENGINEERING

## CONSTRUCTION.

**Chimney.**

The Boston Elevated Railway's Chimney at Lincoln Wharf. Illustrated description of a 251-ft. brick stack having new details at the flues. 500 w. Eng Rec—Dec. 22, 1900. No. 38297.

**Fireproofing.**

Non-Flammable Materials. An illustrated account of tests made of materials rendered non-flammable, by the British fire-prevention committee. 1200 w. Fire & Water—Dec. 1, 1900. No. 38040.

The Fire-proofing of the Government Printing Office, at Washington, D. C. An account of the competition for construction of the fire-proof floors and steel protection, with illustrations of the designs submitted by the successful bidders, and those executed by the Government. 1300 w. Br Build—Nov., 1900. No. 37949 D.

**Ice Houses.**

Cheap Ice Houses. Suggestions for a farmer's ice house, scheme for a 50-ton ice house, various floors, a 5,000-ton house, etc. Ill. 2500 w. Ice & Refrig—Dec., 1900. No. 38022 C.

**Materials.**

Building Materials at the Paris Exhibition, 1900. A review of the exhibits of this class, with comments on the attempted classification. 3200 w. Engng—Dec. 7, 1900. Serial. 1st part. No. 38191 A.

**Rolled Joists.**

The Use of Rolled Joists in Construction. A. T. Walmisley. Read before the British Archt. Assn. An interesting and valuable paper, with many diagrams, and short general discussion. 8700 w. Builder—Dec. 1, 1900. No. 38101 A.

**Roof Trusses.**

Joints in Wooden Trusses. Letters from H. S. Jacoby and F. E. Kidder on the working stresses to be adopted in designing such trusses. 1300 w. Eng Rec—Dec. 29, 1900. No. 38428.

**Sprinklers.**

Eliminating the Conflagration Hazard. Everett U. Crosby. Devoted to a discussion of the possible elimination of conflagrations in cities by the universal installation of automatic sprinkler systems. Gives information of the system in an appendix, and also a general discussion. 11500 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38142 E.

## HEATING AND VENTILATION.

**Blowing Fans.**

Methods of Testing Blowing Fans. R. C. Carpenter. Read before the Am. Soc. of Heat. & Ven. Engs. Considers certain difficulties experienced in testing, the methods, etc. 4600 w. Dom Engng—Dec. 20, 1900. No. 38261 C.

**Flanges.**

The Standardization of Flanges. Robert E. Atkinson. Read at the Oct. meeting of the Inst. of Heat. and Ven. Engs., in London. A general discussion of the subject. 4800 w. Plumb & Dec—Dec. 1, 1900. No. 38213 A.

**Greenhouses.**

A New Method of Steam Heating for Greenhouses. T. Eckhardt, in the *Florists' Exchange*. Illustrated description of a new method of heating greenhouses for tropical plants, with a comment by L. R. Taft. 3000 w. Met Work—Dec. 1, 1900. No. 37954.

**Public Library.**

Ventilation and Heating of the Atlanta, Ga., Public Library. Illustrated description of the new Carnegie library heating plant, which includes an indirect apparatus for most of the building and a direct apparatus, supplemented by direct-indirect radiation, for the stock-room. 1500 w. Eng Rec—Dec. 1, 1900. No. 37947.

**Radiators.**

Surface of Radiators in Room Heating. Ernest T. Child. A comparison of the methods of determining the proper amount of steam radiating surface. 2700 w. Gas Engs' Mag—Dec. 10, 1900. No. 38465 A.

**Drainage.**

Essential Features of House Drainage. Rudolph Hering. Considers in detail the requirements of a perfect system of house drainage. 4900 w. Dom Engng—Dec. 20, 1900. No. 38257 C.

**Pipes Freezing.**

Freezing of Soil and Vent Pipes. A copy of inquiries sent out relating to this subject, and the replies received. 1800 w. Dom Engng—Dec. 20, 1900. No. 38258 C.

**Plumbing.**

Practical Plumbing. An address on the proper installation of sewer, waste,

*We supply copies of these articles. See introductory.*

soil and ventilation pipes. 3200 w. Dom Engng—Dec. 20, 1900. No. 38259 C.

**Residence.**

Plumbing Details in the Residence of Dr. E. H. Dunham. Illustrated description of the numerous special features in a large New York residence; these include details of the water-supply apparatus as well as the drainage system. 2200 w. Eng Rec—Dec. 22, 1900. No. 38401.

**Soldering.**

Burning and Blow Pipe Soldering. An illustrated article on the use of the oxyhydrogen flame for lead burning. 2500 w. Met Work—Dec. 15, 1900. No. 38177.

**Water Closets.**

A History of Water Closets. Glenn Brown. Read before the Am. Inst. of Archts. Reviews the history, and describes early types. Ill. 1600 w. Dom Engng—Dec. 20, 1900. Serial. 1st part. No. 38260 C.

**Water Service.**

Water Service in a Suburban Residence. Illustrated description of a piece of plumbing work which has given excellent satisfaction. 1300 w. Met Work—Dec. 1, 1900. No. 37955.

### MISCELLANY.

**Elevators.**

The "Escalator," or Continuous Elevator. Illustrates and describes this device, as shown at the Paris Exhibition. 1200 w. Engng—Nov. 30, 1900. No. 38112 A.

The New Elevators of the Eiffel Tower. From *La Nature*. An illustrated description of changes made, necessitated by the installation of new elevators, and the difficulties overcome. 1100 w. Sci Am Sup—Dec. 8, 1900. No. 38050.

The New Fives-Lille Elevators at the Eiffel Tower (Les Nouveaux Ascenseurs Fives-Lille à la Tour Eiffel). G. Leugny. A description of the new and enlarged elevator system installed for the service of the exposition of 1900. 2000 w. Revue Technique—Nov. 25, 1900. No. 38324 D.

**Landscape Architecture.**

Landscape in Connection with Public Buildings in Washington. Abstract of a paper by F. L. Olmsted, Jr., before the Am. Inst. of Archts., explaining the unfortunate results of a failure to group the public buildings of Washington in harmony with l'Enfant's project. 3300 w. Eng Rec—Dec. 29, 1900. No. 38426.

## CIVIL ENGINEERING

### BRIDGES.

**Accidents.**

Some Peculiar Railroad Bridge Accidents. J. I. Boggs. An account of accidents on the Houston & Texas Central Ry., showing the remarkable performance of some old designs in railroad bridges. 800 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37978 E.

**Bridge Raising.**

Raising the Boston Bridge, Near McKeesport. Illustrated description of the method of raising half of a cantilever bridge by adding supports 14 ft. high on the top of the pier. 900 w. Eng Rec—Dec. 15, 1900. No. 38180.

**Concrete.**

Highway Bridges of Concrete. Daniel B. Luten. Illustrates and describes the construction, and considers the adaptability of this material for bridge designs, and the cost. 1000 w. Munic Engng—Dec., 1900. No. 37988 C.

**Concrete-Steel.**

The Green and Goat Islands Concrete-Steel Bridges at Niagara Falls, N. Y. An illustrated account of the new bridges under construction at the points named, and the difficulties met. 2000 w. Eng News—Dec. 6, 1900. No. 38078.

**Development.**

The Developments of the Nineteenth Century in Bridge Design and Construction. A brief historical review of bridge building and materials used, based on articles by Prof. G. C. Mehrtens, published in *Zeitschrift des Vereines Deutscher Ingenieure*. 2000 w. Eng News—Dec. 13, 1900. No. 38164.

**Highway Bridge.**

Economical Steel and Masonry Highway Bridge Work at Rye, N. Y. Illustrates and describes a steel girder and concrete floor bridge over Blind Brook. 700 w. Eng News—Dec. 13, 1900. No. 38165.

**London Bridge.**

The Widening of London Bridge. Briefly reviews the history of the bridge and illustrates and describes the present scheme, chiefly devoted to dealing with the lateral expansion of the footways. 2500 w. Engr, Lond—Dec. 21, 1900. No. 38453 A.

The Widening of London Bridge. Editorial, with illustrations on the proposed alterations, which will widen the foot-

ways. 1300 w. Builder—Dec. 8, 1900. No. 38218 A.

**Rebuilding.**

Reinforcing and Rebuilding the Cornwall Bridge Piers. Illustrated description of a steel caisson and coffer-dam placed about a masonry pier and filled with concrete for the purpose of increasing the stability of the pier. 2000 w. Eng Rec—Dec. 29, 1900. No. 38421.

**Requirements.**

Electric Railway Bridges. An editorial discussion of the new requirements of the Massachusetts Board of Railroad Commissioners for bridges supporting electric railways. 1000 w. Eng Rec—Dec. 29, 1900. No. 38419.

**Rhine.**

The Railway Bridge Over the Rhine at Worms (Die Eisenbahnbrücke über den Rhein bei Worms). H. Geibel. A very full account of this important structure, with details of the construction and photographs in various stages of erection. 12000 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1900. No. 38317 D.

**Riveting.**

A Direct Method of Spacing Rivets and Finding the Position, etc., of Stiffeners in Plate Girders. E. Schmitt. Presents a graphical method of finding the rivet spacing, etc., of plate girders which greatly lessens the labor. 4500 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37977 E.

**Specifications.**

The American Bridge Company's New Specifications. A series of extracts from the specifications for steel railway bridges, giving the more important changes from previous specifications and an explanation of the reasons for certain of them. Also an editorial discussion of the value of these specifications. 3800 w. Eng Rec—Dec. 1, 1900. No. 37948.

**Stresses.**

Some Bridge Matters. Editorial discussion of matters relating to bridge design, and the straining action on rivets, etc. 2000 w. Engng—Nov. 23, 1900. No. 37995 A.

**Swing-Bridges.**

Swing-Bridges Over the Weaver. Illustrates and describes the new swing-bridges over the river at Northwich, where the salt industry often causes subsidence, and thus made the designing more than usually difficult to meet the conditions. 3000 w. Engng—Dec. 14, 1900. No. 38268 A.

**Viaduct.**

The New Kinzua Viaduct. Illustrated description of the general features, details of construction and methods of erection of a heavy steel viaduct 2,053 ft. long and 301 ft. in maximum height. 3000 w. Eng Rec—Dec. 1, 1900. No. 37943.

The New Kinzua Viaduct. An editorial discussion of the difference in design between the old and new structures. 1000 w. Eng Rec—Dec. 22, 1900. No. 38292.

The Kinzua Viaduct. Illustrated detailed description of the reconstruction of a heavy steel viaduct on the Bradford Div. of the Erie R. R. 3200 w. R R Gaz—Nov. 30, 1900. No. 37972.

The Kinzua Viaduct of the Erie Railroad Company. C. R. Grimm. An illustrated detailed description of this reconstructed viaduct, with reasons for the design chosen, and information of interest. 3000 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37979 E.

**Wooden Bridge.**

The Old Y Bridge at Zanesville. Illustrated description of the wooden Burr bridge, some of its trusses of 150-ft. span, built in 1831-32. 800 w. Eng Rec—Dec. 22, 1900. No. 38295.

## CONSTRUCTION.

**Dams.**

Building of the Great Wachusett Dam. J. A. Stewart. An illustrated account of a dam that will provide the city of Boston with an extensive storage basin of capacity only surpassed by one other in the world. 1100 w. Sci Am Sup—Dec. 15, 1900. No. 38140.

The Cascade Rock-Fill on the Erie R. R. Sketch plan and illustration, with brief description. 600 w. Eng News—Dec. 27, 1900. No. 38446.

The Latest Soundings at the Break in the Austin Dam. Thomas U. Taylor. A report of investigations made in Oct. and Nov., 1900. Ill. 1400 w. Eng News—Dec. 6, 1900. No. 38081.

**Earthwork.**

Rapid Earthwork Calculation. H. P. Gillette. An explanation of method. 2500 w. Eng News—Dec. 12, 1900. No. 38166.

**Framework.**

The Theory of Simple Frameworks (Beitrag zur Theorie des einfachen Fachwerkbalkens). Prof. Ramisch. A graphical examination of simple truss forms. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38309 B.

**Roof Trusses.**

See Architectural Engineering, Construction.

**Tunneling.**

The East Boston Tunnel Shield. Illustrated description of a roof shield for a tunnel under Boston harbor, noteworthy for the provision made for bulk-heading its front, when necessary. 900 w. Eng Rec—Dec. 29, 1900. No. 38423.

**Water-Jet.**

The Water-Jet as an Aid to Engineering Construction. L. Y. Schermerhorn. Gives a review of the applications of the water-jet to the work of the engineer, giving the history of the early development, and typical cases where the results were satisfactory. Also discussion. 9000 w. Pro Engs' Club of Phila—Nov., 1900. No. 38019 D.

## HYDRAULIC AND MARINE.

**Canals.**

A Remarkable Old Waterway. Illustration and descriptive account of the Kennet and Avon Canal, and Devizes Locks. 2000 w. Engr, Lond—Nov. 30, 1900. No. 38117 A.

Canals from the Lakes to New York. Discussion of papers by Joseph Mayer and George Y. Wisner. 7000 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37980 E.

Canals from the Lakes to New York. Continued discussion of papers by Joseph Mayer and George Y. Wisner. 19300 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38444 E.

Increased Transportation Facilities. Albert H. Scherzer. A plea for the development of inland waterways, especially a ship canal in United States territory from the Great Lakes to the Seas, in advance of building an isthmian canal. 1800 w. Marine Rev—Nov. 29, 1900. No. 37982.

The Preliminary Report of the Isthmian Canal Commission. Abstract of the first part of this report, dealing with dimensions, routes, harbors, etc. 5400 w. Eng News—Dec. 20, 1900. Serial. 1st part. No. 38220.

The Isthmian Canal Commission's Report. The full text of the first part of the report submitted on Nov. 30; it covers the organization of the Commission's working force, a total of over 800 men, the investigations made on foreign canals, the results of the examination of the work at Panama, special surveys in the Darien country, and the examination of the Nicaragua Canal project. Also an editorial on this portion of the report. 10400 w. Eng Rec—Dec. 8, 1900. Serial. 1st part. No. 38085.

**Docks.**

Dock Extensions in the Bristol Channel. Information concerning proposed extensions at various ports. 2200 w. Engr, Lond—Dec. 14, 1900. No. 38265 A.

40,000-Ton Capacity Ore Dock of the Great Northern Ry., at West Superior, Wis. Drawings, and brief statement of dimensions, with comment on the excellence of the work. 700 w. Eng News—Dec. 20, 1900. No. 38228.

The Construction of the Docks on the Moldau, near Prague (Baufortschritt bei dem Flosshafen auf der Kaiserwiese au der Moldau bei Prag). M. Machulka. Describing and illustrating the work on the new basins, of 34 acres in extent, now under construction near Prague. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1900. No. 38347 D.

The New Hoboken Terminal of the North German Lloyd Line. Illustrated description of the piers and buildings to be erected on the site of those destroyed in the summer of 1900. The fireproofing and structural steel-work contain many unusual features. 2700 w. Eng Rec—Dec. 22, 1900. No. 38293.

Warned by the Conflagration. Illustration of the new terminals and piers to be built for the North German Lloyd Co., in Hoboken, N. J., with brief description. 800 w. Fire & Water—Dec. 22, 1900. No. 38415.

**Dredging.**

A New Method of Applying Cutting Machinery to Suction Dredges. George Higgins. Read before the Victoria Inst. of Engs. Explains the need of cutters in dealing with certain material, and gives illustrated description of machinery to be applied to a suction dredge in New South Wales. 3500 w. Prac Engr—Nov. 23, 1900. Serial. 1st part. No. 38011 A.

**Filtration.**

Description of Experimental Filter Plant at Pittsburg, and Results of Experiments. Morris Knowles. An account of the investigations which were carried on at the experimental filter plant, giving a description of the apparatus used, views of interesting details, and a summary of results. Ill. 10000 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38144 E.

The Lower Roxborough Filter Plant at Philadelphia. Illustrated description of five covered sand filters and a covered clear water basin, all of concrete, having a capacity of 6,400,000 gallons in 24 hours with one filter idle. The work involves a large amount of special concrete construction. 3400 w. Eng Rec—Dec. 8, 1900. No. 38083.

The Construction of Gravity Sand Filters at Nyack, N. Y. G. N. Houston. Gives illustrated description of plant, and details of construction, stating the conditions to be met and the methods adopted. 3500 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38442 E.

Results of Water Filtration at Albany. Dr. Martin MacHarg. Extracts from a paper read before the Albany Co. Med. Soc. concerning the reduction in typhoid fever in Albany since the introduction of filtered water. 700 w. Eng Rec—Dec. 1, 1900. No. 37946.

The English System of Water Filtration. Floyd Davis. Describes the English methods of sand filtration and the

care needed. 1500 w. Munic Engng—Dec., 1900. No. 37990 C.

**Flow.**

Hydraulic Theories on the Flow of Water. A letter from Charles H. Tutton, on the formulas deducible by various assumptions from elementary laws of physics. 2000 w. Eng Rec—Dec. 29, 1900. No. 38429.

Measuring the Flow of Water from Pipes. W. H. Booth. Describes a method of making rapid approximations. 600 w. Am Mach—Dec. 27, 1900. No. 38413.

Mr. Sullivan's Hydraulic Formula. A letter from I. P. Church comparing a large number of formulas for the flow of water in open channels and long pipes. 400 w. Eng Rec—Dec. 29, 1900. No. 38427.

**River Improvement.**

The Results of the Improvement of Navigable Streams (Die Erfolge der Fahrwasserbesserung Schiffbarer Flüsse). A. v. Weber-Ebenhoff. A review of the commercial results which have followed river improvement works in Austria and Germany during the past ten years. 7500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1900. No. 38347 D.

Works for the Improvement of the Mississippi River, as Shown at the Paris Exposition of 1900. Describes the interesting exhibits of models, drawings and maps of the various works. 2400 w. Ry & Engng Rev—Dec. 15, 1900. No. 38199.

**Standpipe.**

Deterioration of the Peoria Standpipe. A. B. Herrick. Extracts from paper by D. H. Maury are given, with the writer's views, and instances of similar deterioration before electric railways were located near. Ill. 3000 w. St Ry Jour—Dec. 1, 1900. No. 37984 D.

**Tank.**

Failure of an Elevated Wooden Water Tank by Rusting of Hoops from the Inside. Gives particulars of the failure of a tank belonging to the mills of the Bamford Bros. Silk Mfg. Co., of Paterson, N. J. Ill. 500 w. Eng News—Dec. 27, 1900. No. 38448.

**Water Purification.**

The Effect of Physical Agents on Bacterial Life. Allan Macfadyen. A lecture before the Royal Inst. of Great Britain. Gives information regarding the physical conditions favoring the presence and multiplication of bacteria, and to their destruction. 5000 w. Pop Sci M—Jan., 1901. No. 38284 C.

The Purification of Drinking Water by Ozone (Reinigung von Trinkwasser durch Ozon. Dr. Thomæ. A review of the processes exhibited at the Paris Exposition, with a general discussion of the practicability of the method. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 8, 1900. No. 38318 D.

**Water Supply.**

Iron Removal from the Prenzlau Water Supply. From *Zeitschrift d. Ver Deutscher Ing.* Illustrated description of works drawing a supply from driven wells, which is aerated and filtered in Worms apparatus. An Intze water tower is another feature of the plant. 1800 w. Eng Rec—Dec. 15, 1900. No. 38179.

The Forbell Case. A review of a decision by the New York Court of Appeals practically forbidding the use of ground water for purposes of municipal supply, with a statement of the possibility of obtaining a reconsideration of the decree by means of data obtained from agricultural experiment stations. 1000 w. Eng Rec—Dec. 1, 1900. No. 37942.

I. The Latest Decision Affecting Underground Water Supplies, Borough of Brooklyn, New York City. II. British Law in Regard to Underground Water. J. Shiress Will. British law acknowledges no ownership except when in well-defined channels. New York law sustains the claim for ownership. 3800 w. Eng News—Dec. 6, 1900. No. 38079.

The Removal of Iron from Water. A description of small works in Germany and a review of experiments by the Massachusetts Board of Health at Watertown, Marblehead and Provincetown. 2500 w. Eng Rec—Dec. 29, 1900. No. 38425.

Water Supply of Greater New York. M. N. Baker. Reviews the reports of John R. Freeman, and of the Merchants' Association of New York, giving the conclusions stated in each report. 8000 w. Munic Affairs—Sept., 1900. No. 38291 C.

## MATERIALS.

**Artificial Stone.**

Manufacture of Silico-Calcareous Blocks (Fabrication des Agglomérés Silico-Calcaires). H. Cuenod. A description of the Schwarz process for forming artificial stone with lime and sand under the action of vapor of water at a high temperature. 1200 w. Génie Civil —Dec. 1, 1900. No. 38307 D.

**Brick.**

Brick and Tile Works at Schernbeck, near Wesel (Thon und Falzziegelwerk der Gewerkschaft Union in Schernbeck bei Wesel). H. Seifert. With full plans of this modern plant, including pressing and molding machinery, drying and burning kilns, etc., etc. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 24, 1900. No. 38315 D.

**Cement Tests.**

The Practical Value of Accelerated Ce-

ment Tests. A translation of investigations by M. Gary, of the practical value of cements condemned by accelerated tests. 3500 w. Eng Rec—Dec. 8, 1900. No. 38086.

**Concrete.**

The Concrete Lock Near St. Paul. Description of a concrete plant of 300 yds. daily capacity, constructed on the top and slope of a bluff and operated largely by compressed air. 2100 w. Eng Rec—Dec. 22, 1900. No. 38298.

**Reinforced Concrete.**

A Steel-Concrete Stable Roof. Illustrated description of a 200 x 89 ft. roof having steel trusses and a covering of concrete slabs, stiffened by steel framing and wire netting. 1100 w. Eng Rec—Dec. 22, 1900. No. 38299.

The Failure of a Concrete-Steel Grain Elevator at Duluth, Minn. An illustrated description of the structure and its failure, with analysis of its cause. 500 w. Eng News—Dec. 27, 1900. No. 38445.

**Rolled Joists.**

See Architectural Engineering—Construction.

**White Lead.**

A New Process for the Manufacture of White Lead. Romyn Hitchcock. A review of processes devised for the manufacture of white lead, presenting also a new process by J. W. Bailey. 2400 w. Eng & Min Jour—Dec. 8, 1900. No. 38096.

## MEASUREMENT.

**Leveling.**

Notes on Precision Leveling (Note sur un Niveau de Précision). MM. Böet and Huberti. Describing improvements made by the writers in the so-called "dumpy" level, and discussing methods of use. 2500 w. Rev Univ des Mines—Nov., 1900. No. 38338 H.

The Theory and Practice of Precise Spirit Leveling. Discussion of the paper by David A. Molitor. Ill. 26000 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37981 E.

**Maps.**

Behsel's Plan of Vienna (Der Behsel'sche Plan von Wien). S. Wellisch. An examination of the map of Vienna made in 1824, compared with existing landmarks. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38310 B.

The Determination of the Accuracy of a Map (Die Genauigkeitsbestimmung eines Planes). S. Wellisch. Showing the method of determining the true scale of a map, also the mean error. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 30, 1900. No. 38313 B.

**Mine Surveying.**

See Mining and Metallurgy, Mining.

**Surveying.**

History of Solar Surveying Instruments. J. B. Davis. Prepared to supplement paper by Dunbar D. Scott, on "Evolution of Mine-Surveying Instruments." Remarks on land surveys in general, and detailed history of solar instruments. Ill. 6000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38430 D.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. Charles L. Crandall. Explains the method of adjustment of a compass survey, and its improper application to transit surveying; gives a method in detail that can be used mechanically the same as the old compass survey method. 2200 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38441 E.

## MUNICIPAL.

**Dust Prevention.**

Oil on Highways. Gives results of experiments, data on cost, and discusses advantages of its use on roadbeds, street railways and highways. 1600 w. St Ry Rev—Dec. 15, 1900. No. 38236 C.

**Laboratories.**

Municipal Water-Works Laboratories. George C. Whipple. Information concerning the laboratories already established and their work, and discussing the use of laboratories for other municipal needs. Ill. 4500 w. Pop Sci M—Dec., 1900. No. 37976 C.

**Paris.**

Paris Drainage and Water Supply. On the great sums spent on these undertakings and the unsatisfactory results. 2000 w. Engr, Lond—Dec. 14, 1900. No. 38264 A.

**Pavements.**

Asphaltum for a Modern Street. S. F. Peckham. Information concerning the deposits and varieties, their origin, refining, etc. Ill. 4300 w. Pop Sci M—Jan., 1901. No. 38283 C.

Automobiles and City Pavements. George E. Walsh. On the saving in wear to city pavements between heavy motor trucks equipped with broad, flat, hard rubber tires, and the ordinary horse truck with flat iron tires. 1200 w. Elec Rev, N. Y.—Dec. 26, 1900. No. 38412.

Recent Paving Practice in Lafayette, Ind. W. K. Eldridge. Describes the methods of constructing asphalt pavements, the materials used, and precautions taken. 1200 w. Munic Engng—Dec., 1900. No. 37989 C.

**Sewage.**

Aldershot Camp Sewage Farm. Describes a sewage farm that has been both

a success and a failure, while all the conditions remained the same excepting—the management. Ill. 5000 w. Engng—Nov. 30, 1900. No. 38110 A.

Bradford Sewage and Its Treatment. F. W. Richardson. A paper before the British Assn., describing the peculiar character of the sewage, due to the large quantities of waste liquors from woolen mills and dyeing establishments, and the methods of treatment which have been tried. 4200 w. Eng Rec—Dec. 8, 1900. No. 38087.

Purification of Sewage by Bacterial Methods. Leonard P. Kinnicutt. An explanatory outline of what takes place, with a review of the methods classed under this head. Ill. Also general discussion. 10700 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38143 E.

Results Obtained with Large Experimental Septic Sewage Tanks and Rapid Filtration at Woonsocket, R. I. George A. Carpenter. Abstract of paper read before the League of American Municipalities at Charleston, S. C. 1200 w. Eng News—Dec. 20, 1900. No. 38232.

The Septic Tank Experiments of the Massachusetts State Board of Health. A review of experiments indicating that a septic tank may be a useful adjunct to filters, but that anaerobic action may be carried too far. Also describes experiments with very rapid filtration through 10½ ft. of broken stone, giving remarkable results. 2800 w. Eng Rec—Dec. 22, 1900. No. 38296.

The Treatment of London Sewage. Frank Clowes. On the advantages of bacterial treatment, giving information based on personal experiments and observation. Also discussion. 7000 w. Jour Soc of Arts—Dec. 14, 1900. No. 38404 A.

**Sewers.**

Building a Sewer Under a Bridge Pier. Illustrated description of the method of supporting one column of a 4-post bent of a heavy viaduct while a 16½ ft. sewer was built below it. 700 w. Eng Rec—Dec. 1, 1900. No. 37945.

Inspecting and Cleaning an Intercepting Sewer at Columbus, O. From the last annual report of Julian Griggs, Chief Engineer of the Dept. of Public Works. Describes interesting work. 1000 w. Eng News—Dec. 27, 1900. No. 38447.

The Brookfield, Mo., Sewerage System. R. P. Garrett. Illustrated description of a small system requiring some sewage purification, but entailing the utmost economy in first cost. 1200 w. Eng Rec—Dec. 22, 1900. No. 38294.

The Ocean Outlet Sewer at Spring Lake, N. J. Illustrated description of an outfall of a sewerage system, where an earlier outfall became clogged with sand. 500 w. Eng Rec—Dec. 29, 1900. No. 38424.

**Street Improvements.**

How to Brighten Street Frontages. Editorial on the London street improvements, criticising the editorial opinions expressed in the *Builder*, and discussing some of the schemes. 1600 w. Jour Gas Lgt—Nov. 27, 1900. No. 38089 A.

**Subways.**

The City of London Subways. Illustrated description of existing subways and manner of lighting. 900 w. Elect'n, Lond—Nov. 30, 1900. No. 38108 A.

**Washington, D. C.**

The Monumental Grouping of Government Buildings in Washington, D. C. Extracts from a paper by E. V. Seeler, before the A. I. A., on the l'Enfant plan for the development of Washington, and the unfortunate departure from it. 2800 w. Eng Rec—Dec. 22, 1900. No. 38400.

**Waste.**

The Disposition of City Waste. E. R. Pritchard. Discusses the collection, sorting, sanitary and economic disposition, etc. 3400 w. Dom Engng—Dec. 20, 1900. No. 38256 C.

### MISCELLANY.

**Education.**

The Laboratory Work of an Engineering School (Ueber Laboratoriumsarbeiten an der Bau-Ingenieurschule). Prof. Friedrich Steiner. Discussing especially the use of models for the study of framed structures. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38308 B.

**Engineering.**

Interlapping of Railway, Civil and Mechanical Engineers. Address by H. Wade Hibbard, followed by general discussion. 8400 w. Cent Ry Club—Nov., 1900. No. 38209 C.

Mr. L. F. Vernon-Harcourt on the Profession of Civil Engineering. Review of an article that appeared in the *National Review*. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38148 A.

## ELECTRICAL ENGINEERING

### COMMUNICATION.

**Cables.**

Cable Laying in Arctic Waters. George F. Porter. Illustrated account of the laying of the St. Michael-Cape Nome cable and the wreck of the cable-ship. 1400 w. Elec Rev. N. Y.—Dec. 5, 1900. No. 38059.

The Action of Telegraph Signals in Long Cables (Ueber die Darstellung des Verlaufes Telegraphischer Zeichen in Langen Kabeln). Dr. F. Breisig. An examination of the course of a signal over the length of a cable, plotted graphically, taking into account the transmitting and receiving instruments. 5000 w. Elektrotech Zeitschr—Dec. 13, 1900. No. 38367 B.

**Paris Exhibition.**

Telegraphs and Telephones at the Paris Exhibition. J. Gavey. A brief review of the exhibits of this class which show novelty or illustrate the progress of the last decade. Ill. 5000 w. Elect'n, Lond—Nov. 23, 1900. No. 38010 A.

**Rapid Telegraphy.**

The Pollak-Virág Telegraph. Herr Pinter. Translation of a paper read before the Congress of Electricians at Paris. Brief illustrated description of the system, with account of recent trials and progress. 4000 w. Engng—Dec. 7, 1900. No. 38194 A.

**Space Telegraphy.**

Wireless Telegraphy. G. W. de Tunzelmann, in *Knowledge*. Illustrates and describes the apparatus of Prof. A. Popoff, and of Guglielmo Marconi. 2700 w. Sci Am Sup—Dec. 29, 1900. No. 38282.

**Telegraphone.**

The Telegraphone: A Magnetic Speech-Recorder. Valdemar Poulsen. Illustrated description of the principles and arrangement of this invention. 1600 w. Elect'n, Lond—Nov. 30, 1900. No. 38109 A.

**Telephones.**

Independent Telephone Exchange Ownership as an Investment. Burt Hubbell. Discusses the points of importance, reaching a favorable conclusion. 1500 w. Elec Rev, N. Y.—Dec. 12, 1900. No. 38161.

The Long-Distance Service of the Erie Telephone System. Arthur Stanley Riggs. Describes the growth of this service in the middle-western States. Ill. 3500 w. Elec Rev, N. Y.—Nov. 28, 1900. No. 37963.

## DISTRIBUTION.

**Arrangement.**

The Arrangement of the Distributing Network. Charles A. Gillin. Considers the subject under the heads of 1, Uniformity of pressure; 2, Maximum variation of pressure; 3, Continuance of supply of electric energy; 4, Facility in fault localization. 3000 w. Elec Engr, Lond—Nov. 30, 1900. Serial. 1st part. No. 38103 A.

**Distribution Systems.**

See Street and Electric Tramways.

**Mains.**

Practical Notes on Electric Mains. Part first gives a general review, and discusses the management of men; other parts will consider cable laying and jointing, cable testing, sub-stations, house connections, street-lighting, etc. 2000 w. Elec Engr, Lond—Nov. 23, 1900. Serial. 1st part. No. 38015 A.

**Ship Plants.**

Electric Plants on Modern-Warships (Die Elektrischen Anlagen Neuerer Kriegsschiffe). H. Grauert. A very full account of electrical installations on recent German warships, with diagrams of switchboards, etc. Two articles. 10000 w. Elektrotech Zeitschr—Nov. 22, 29, 1900. No. 38358 each B.

**Small Installations.**

Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations. H. A. Earle. Read before the Manchester Section of the Inst. of Elec. Engs. Considers the choice of machinery and distribution in sub-stations and small installations; the systems are compared. 6000 w. Elec Engr, Lond—Nov. 30, 1900. No. 38104 A.

**Switch.**

A New High Voltage Cut-Out Switch (Ueber Einen Neuen Hochspannungsausschalter). J. Froitzheim. Describing a heavy apparatus using compressed air for service in large stations. 1200 w. Elektrotech Zeitschr—Nov. 22, 1900. No. 38359 B.

**Wiring.**

Interior Wiring. Charles E. Knox. Illustrated description of the wiring of the thirty-two story Park Row building in New York City. 2000 w. Am Elect'n—Dec., 1900. No. 38075.

Pipes for Carrying Wires. P. I. Panamolo. Considers some points in regard to the bending of pipes used to carry wires, and the work generally. Ill. 1800 w. W Elect'n—Dec. 15, 1900. No. 38185.

## ELECTRO-CHEMISTRY.

**Batteries.**

Bichromate Batteries. Alfred G. Dell. The writer's experience in the use of bichromate of potash batteries when used for induction coils. 800 w. Elec Rev. N. Y.—Dec. 5, 1900. No. 38060.

**Bleaching.**

The Haas & Oettel System of Electrical Bleaching. (Die Elektrischen Bleichapparate, System Haas & Oettel. Dr. Felix Oettel). Giving the details of the improved apparatus for the production of chlorine by the electrical decomposition of com-

mon salt, for bleaching purposes. 2500 w. Zeitschr f Elektrochemie—Nov. 22, 1900. No. 38538 G.

**Carbide.**

The Calcium Carbide Works at Milan (L'Officina pel Carburo di Calcio di Milano). Dr. V. Lucchini. With illustrations showing the general arrangement of the works. The Gin & Leleux electric furnace is used. 2500 w. Elettricita—Dec. 1, 1900. No. 38351 B.

The Manufacture of Calcium Carbide. John B. C. Kershaw. Considers the efficiency and yield of carbide furnaces, and lessons derived from the study. 1200 w. Elect'n, Lond—Nov. 23, 1900. Serial. 1st part. No. 38009 A.

**Electrodes.**

The Distribution of Current on the Surface of Electrodes. (Ueber die Bestimmung der stromvertheilung auf Elektrodenflächen.) Dr. K. Norden. A paper before the German Electrochemical Society, showing the method of determining the value of electrode surface. 3000 w. Zeitschr f Elektrochemie—Nov. 22, 1900. No. 38537 G.

**Electrolysis.**

The Electrical Decomposition of Water on a Large Scale. (Ueber Elektrische Wasserzersetzung im Grossen.) Dr. O. Schmidt. A discussion of the electrolytic decomposition of water on the large scale for the commercial production of oxygen and hydrogen. 4500 w. Zeitschr f Elektrochemie—Nov. 15, 1900. No. 38540 G.

The Electrolysis of Fused Salts. (Demonstration zur Elektrolyse Geschmolzener Salze.) Dr. R. Lorenz. A paper read before the German Electrochemical Society, giving data of practical importance in electro-chemistry, with discussion. 4000 w. Zeitschr f Elektrochemie—Nov. 15, 1900. No. 38539 G.

**Electromotive Force.**

The Electromotive Force of Metals in Cyanide Solutions. S. B. Christy. Gives an outline of the development of the modern electro-chemical theory, an account of experimental work on the subject given, and the methods used in this investigation. 23300 w. Trans Am Inst of Min Engs—Sept., 1899. No. 38439 D.

**Lead.**

The Electrolytic Separation of Metallic Lead from Solutions, and the formation of Spongy Lead. (Die Elektrolytische Ausfällung von Metallischem Blei aus Lösungen und die Bleischwammbildung.) L. Glaser. A general discussion of methods, and an account of the author's experiments. Serial, Part 1. 2500 w. Zeitschr f Elektrochemie—Dec. 13, 1900. No. 38542 G.

**Separation.**

The Electrical Separation of Metals of the Alkalies from Fused Alkaline Chlorides. Arthur Fischer. Giving details of apparatus used in practical work. 2500 w. Zeitschr f Elektrochemie—Dec. 6, 1900. No. 38541 G.

## ELECTRO-PHYSICS.

**Alternating Currents.**

Alternating Current Laboratory Experiments and Commercial Tests. Fitzhugh Townsend. A description of a series of experiments which make up the alternating current laboratory course prescribed for the fourth year students in the electical engineering department of Columbia University. 15300 w. Sch of Mines Quar—Nov., 1900. No. 38288 D.

The Resistance Offered by Iron Conductors to Alternating Currents. Abstract of an article by C. Feldmann and J. Herzog, in *Elektrotechnische Zeitschrift*. A study of this subject, showing its practical importance in regard to railways worked by multiphase currents, where the rails are used as a return. 2200 w. Elec Engr, Lond—Nov. 23, 1900. No. 38016 A.

**Magnetic Attraction.**

On the Mechanical Forces in Dynamos Caused by Magnetic Attraction. B. A. Behrend. Deduces a new formula applicable to dynamos, showing its agreement with observation. 1300 w. Trans Am Inst of Elec Engs—Nov., 1900. No. 38286 D.

**Magnetism.**

Torsional Magnetostriction in Strong Transverse Fields and Allied Phenomena. C. Barus. Methods of experimenting are described and the results discussed. 4000 w. Am Jour of Sci—Dec., 1900. No. 37959 D.

**Terrestrial Magnetism.**

Action of Terrestrial Magnetism Upon a Magnetized Chronometer (Action du Champ Magnetique Terrestre sur la Marche d'un Chronometre Aimanté). A. Cornu. With especial reference to the effect of magnetism upon the chronometers of iron vessels. 2500 w. Comptes Rendus—Nov. 26, 1900. No. 38334 D.

**Transformers.**

The Action of Unloaded Transformers for Polyphase Currents (Ueber den Leerlauf von Drehstrom Transformatoren). R. Goldschmidt. An examination of the distribution in non-symmetrical transformers. 1500 w. Elektrotech Zeitschr—Nov. 29, 1900. No. 38361 B.

**Vibrations.**

Apparatus for the Detection and Registration of Electrical Vibrations. A. C. Popoff. An account of experimental investigations, with description of apparatus

used. 2200 w. Elec Rev, Lond—Nov. 23, 1900. Serial. 1st part. No. 38014 A.

## GENERATING STATIONS.

**Accumulator.**

The Heinz Accumulator (Accumulateur Heinz). A. Bainville. Describing an improved form of Faure accumulator designed either for portable or for station service. 800 w. Electricien—Nov. 24, 1900. No. 38354 B.

**Alternators.**

Some Notes on the Design of Large Alternators. A. Heyland. Notes having special reference to tests made on the alternators of 1,000 E. H. P., exhibited by the Electricité et Hydraulique, Limited, of Charleroi, at the Paris Exhibition. Ill. 1700 w. Elec Rev, Lond—Dec. 7, 1900. Serial. 1st part. No. 38215 A.

**Compounding.**

The Compounding of Alternators (Appunti sul Compoundaggio degli Alternatori). Marco Tullio Gentile. A graphical and analytical examination, using the vector analysis of the variation limits with compounded alternators. 1800 w. Elettricita—Nov. 24, 1900. No. 38349 B.

**Converters.**

Rotary Converters and Motor-Generators. Frank C. Perkins. An illustrated review of the various uses to which this transforming apparatus is applied. 2200 w. W Elect'n—Dec. 8, 1900. Serial. 1st part. No. 38126.

**Crewe Works.**

Crewe Corporation Electricity Works. Illustrated description of a three-wire system. 3000 w. Elect'n, Lond—Dec. 7, 1900. No. 38212 A.

**Dynamos.**

Series Windings on Compound Dynamos and Their Adjustment. Alton D. Adams. Suggestions of value. 1100 w. Am Elect'n—Dec., 1900. No. 38074.

The Lahmeyer Dynamos at the Exposition (Les Génératrices Electriques Lahmeyer à l'Exposition). G. Leugny. Describing polyphase and continuous current dynamos exhibited at Paris by Lahmeyer, of Frankfort, Germany. 1800 w. Revue Technique—Dec. 10, 1900. No. 38329 D.

**Generating Sets.**

Generating Set of 1,400 Horse Power (Groupe Electrogène de 1,400 Chevaux). A. Boudon. Illustrated description of the vertical steam engine by the Augsburg Machine Works, and direct-connected Lahmeyer alternator, exhibited at Paris. 2000 w. Génie Civil—Dec. 8, 1900. No. 38328 D.

Generating Set of the International Electrical Company, of Liége, and the Van Den Kerchove Company, of Ghent (Groupe Electrogène de la Compagnie International d'Electricité de Liége, et de la Société Anonyme Van Den Kerchove de Gand). A 1,000 kilowatt three-phase generator and horizontal compound engine exhibited at Paris. 1000 w. Electricien—Dec. 1, 1900. No. 38356 B.

Some of the Requisites of Modern Lighting Generator Sets. H. G. Reist. Read at meeting of the Engine Builders' Assn. of the U. S. A statement of the present situation of the steam engine in its relation to electrical generation. 2500 w. Elec Wld & Engr—Dec. 15, 1900. No. 38183.

Standardization of Direct-Connected Generating Units. A review of three papers read before the Engine Builders' Assn. of the United States, on the best methods of designing high-speed engines and generators for direct-connected units, so that the combination, as a whole, will be of the greatest efficiency. 1000 w. Eng Rec—Dec. 8, 1900. No. 38088.

The Dujardin-Schneider Generating Set (Groupe Electrogène Dujardin-Schneider). M. Ademar. Illustrated description of the 1,700 h. p. Dujardin engine, and 1,120 kilowatt Schneider alternator exhibited at Paris. 2500 w. 1 plate. Génie Civil—Nov. 24, 1900. No. 38303 D.

The Ringhoffer-Siemens & Halske Generating Set (Groupe Electrogène Ringhoffer-Siemens & Halske). G. Henry. Description of 1,000 kilowatt generating set, with Ringhoffer vertical engines and Siemens & Halske continuous-current dynamo, exhibited at Paris. 2000 w. 1 plate. Génie Civil—Dec. 1, 1900. No. 38304 D.

**Isolated Plants.**

Electricity at Ardross Castle. Illustrated description of a private installation of unusual interest. 3000 w. Elec Rev, Lond—Nov. 23, 1900. No. 38013 A.

**Montmorency.**

A Modern Canadian Water-Power Plant. An illustrated description of the Montmorency Falls generating station. 1000 w. Am Elect'n—Dec., 1900. No. 38070.

**Power Station.**

Central Electric Lighting and Power Station in the Brooklyn Navy Yard. Illustrated description of this plant. 1300 w. Power—Dec., 1900. No. 38169.

**St. Croix Power Co.**

The Plant of the St. Croix Power Co., of Wisconsin. Henry Floy. Illustrated detailed description of a long-distance transmission plant, having both hydraulic and electrical patents of more than ordinary interest. 8000 w. Trans Am Inst of Elec Engs—Nov., 1900. No. 38285 D.

**Snoqualmie Falls.**

The Snoqualmie Falls Water-Power Plant and Transmission System. An illustrated detailed description of plant for developing the power of these falls in Washington. 9700 w. Eng News—Dec. 13, 1900. No. 38163.

**Testing.**

See Electrical Engineering, Measurement.

**Three-Phase.**

Three-Phase Generators at the Paris Exposition (Dreiphasen-Generatoren der "Electricité et Hydraulique" auf der Pariser Welhausstellung, 1900). A. Heyland. Describing several large alternators and examining their action by plotted curves. 3000 w. Elektrotech Zeitschr—Dec. 6, 1900. No. 38363 B.

## HEATING AND WELDING.

**Carbide.**

See Electro Chemistry.

**Electric Furnaces.**

Some Electric Furnaces for Laboratory Use. Charles L. Norton. Details of construction and operation of several small electric furnaces used in the Rogers Laboratory of Physics, for instruction and research work. Ill. 1400 w. Elec Wld & Engr—Dec. 22, 1900. No. 38239.

## LIGHTING.

**Arcs.**

On Rapid Variations in the Current Through the Direct-Current Arc. W. Duddell. An account of what occurs when the current is periodically varied more or less rapidly over a range which is very small compared with the mean value of the direct current. 4800 w. Elect'n, Lond—Dec. 14, 1900. Serial. 1st part. No. 38262 A.

The Hausen Arc Lamp (Lampe à Arc Hausen). Describing and illustrating three forms of improved arc lamps, for derived currents either continuous or alternating, and differential for continuous current. 1200 w. Electricien—Nov. 24, 1900. No. 38353 B.

**Boston, U. S. A.**

The First Electric Light Plant in Boston. Alton D. Adams. An account of a plant started Nov. 9, 1878. 1000 w. Elec Wld & Engr—Dec. 22, 1900. No. 38240.

**Car Lighting.**

See Railway Affairs, Motive Power.

**Exposition.**

Lighting at the Exposition of 1900 (L'Eclairage à l'Exposition de 1900). H. Guérin. The first of a series treating of the general lighting of the exposition describes the petroleum and alcohol incandescent lamps. Serial. Part I. 2000 w. Génie Civil—Dec. 1, 1900. No. 38805 D.

Lighting the Alexander III. Bridge, Paris. An illustrated description. 900 w. Elec Wld & Engr—Dec. 1, 1900. No. 38035.

The Luminous Decorations of the Palace of Electricity and the Chateau d'Eau (Les Décorations Lumineuses du Palais de l'Electricité et du Chateau d'Eau). With especial reference to the electric projectors and illuminated fountains at the Paris Exposition. 1200 w. Revue Technique—Nov. 25, 1900. No. 38323 D.

**Incandescent.**

Incandescent Lamp Development to the Year 1880. Edwin M. Hammer. Historical résumé based on records of sworn testimony in lamp litigations in the United States and abroad, and decisions of courts; and from patents, text books, published articles, etc. Ill. 3000 w. Elec Wld & Engr—Dec. 1, 1900. Serial. 1st part. No. 38037.

**Nernst Lamp.**

The Nernst Lamp. An illustrated description of the improved lamp, with remarks on changes made. 1700 w. Elect'n, Lond—Dec. 7, 1900. No. 38211 A.

**Plant.**

The Evolution of One Electric Light Plant. W. H. Wakeman. Description of the installation and subsequent changes made, giving information concerning plants appropriate for cities of 50,000 to 300,000 inhabitants. 1400 w. Am Gas Lgt Jour—Dec. 3, 1900. No. 38024.

**Street Lighting.**

Street Lighting by Electric Lamps. F. H. Minshall. Discusses the systems, especially those in use at Croydon, England. 4800 w. Elec Wld & Engr—Dec. 1, 1900. No. 38036.

## MEASUREMENT.

**Compensator.**

An Improved Compensator for the Determination of Electromotive Force (Ein Neuer Kompensator zur Bestimmung Elektromotorischer Kräfte). N. T. M. Wilsmore. Describing an improved form of the Poggendorff-du Bois Reymond apparatus. 1000 w. Elektrotech Zeitschr—Nov. 29, 1900. No. 38362 B.

**Efficiency Test.**

The Efficiency of the Power Station and Transmission Line of the Albion Power Co. J. C. Smith. Abstract of thesis, giving a report of the test made. 1000 w. Sib Jour of Engng—Dec., 1900. No. 38188 C.

**Electrometer.**

Investigations Upon the Ebert-Hoffmann High Voltage Electrometer (Untersuchungen am Ebert-Hoffmanschen Hoch-

spannungselektrometer). Ch. Bäumler. Giving the method and results of a calibration of the instrument, and data for plotting curves. 1800 w. Elektrotech Zeitschr—Dec. 6, 1900. No. 38364 B.

**Meters.**

The Testing of Electric Meters at the Physical-Technical Reichsanstalt (Das Prüfungsverfahren für Gleichstrom Elektricitäts zähler in der Physikalisch-Technischen Reichsanstalt). K. Feussner. With illustrations of the apparatus and details of the methods used for continuous current meters. 4500 w. Elektrotech Zeitschr—Dec. 13, 1900. No. 38365 B.

**Standards.**

Report of the Committee of the American Institute of Electrical Engineers on Units and Standards. Also discussion. 5000 w. Trans Am Inst of Elec Engs—Nov., 1900. No. 38287 D.

**Testing.**

Testing Wagon for Electric Stations (Kabelmesswagen für Elektrische Zentralstationen). Illustrated description of the portable testing plant designed for use in connection with central station work by the Allgemeine Elektrizitäts-Gesellschaft. 2 articles, 3000 w. Elektrizität—Nov. 24, Dec. 8, 1900. No. 38352 each B.

**Wheatstone Bridge.**

Reversible Wheatstone Precision Bridge (Umkehrbare Wheatstone'schen Präcisions-Messbrücken). Dr. M. Th. Edelmann. Showing a simple arrangement of resistances and galvanometers, enabling measurements to be rapidly and accurately made. 1000 w. Elektrotech Zeitschr—Nov. 22, 1900. No. 38360 B.

## POWER APPLICATIONS.

**Crane.**

See Mechanical Engineering, Machine Works and Foundries.

**Electric Clock.**

An "Electric Earth Clock" and Its Construction. N. Monroe Hopkins. Brief review of progress made in time measuring devices, with an illustrated description of the electric clock designed by the writer. 2800 w. Sci Am Sup—Dec. 1, 1900. No. 37953.

**Electric Driving.**

See Mechanical Engineering, Machine Works and Foundries.

**Electric Locomotives.**

Electric Locomotives. H. K. Myers. Principles which determine the size and power of locomotives necessary for various loads and grades. 2300 w. Mines & Min—Dec., 1900. No. 38034 C.

**Electromagnets.**

Lifting Electromagnets. E. B. Clark. Considers the use of electromagnets, the objections urged against them, the amount of power consumed, etc. 2800 w. Am Elect'n—Dec., 1900. No. 38072.

**Farming.**

Electricity in Farming. George E. Walsh. On the progress made, and the room for further application, especially in irrigated regions. 1300 w. Am Elect'n—Dec., 1900. No. 38073.

**Loading.**

See Marine and Naval Engineering.

**Metallurgical Plant.**

Electric Power and Lighting Plant at the Donetz-Jurjewka Metallurgical Works (Die Elektrische Kraftubertragungs und Beleuchtungsanlage auf den Hüttenwerken der Donetz-Jurjewka Metallurgischen Gesellschaft). Ludwig Gohs. Showing the extensive use of electric power in this large Russian works. 4500 w. Elektrotech Zeitschr—Dec. 13, 1900. No. 38366 B.

**Propulsion.**

Electric Propulsion on Canals. Editorial on the recent trials ordered by the Prussian government, on the Finow Canal. 1700 w. Elect'n, Lond—Nov. 23, 1900. No. 38007 A.

**Regulation.**

Shunt-Wound Motors on Railway Circuits. E. C. Parham. An explanation of why the belt on the motor either squeals or flies off when there is a ground-out on the line. 800 w. Am Elect'n—Dec., 1900. No. 38076.

Speed Regulation of Shunt Motors by the Multiple Voltage System. G. L. Hoxie. Considers the methods employed to provide for the speed adjustment, describing especially the multiple voltage system. 1500 w. Sib Jour of Engng—Dec., 1900. No. 38189 C.

**Rock Drill.**

See Mining and Metallurgy, Mining.

**Smoke Prevention.**

See Mechanical Engineering, Steam Engineering.

## TRANSMISSION.

**Long Distance.**

Electric Power Transmission for 153 Miles. A statement of an experiment by the Snoqualmie Falls Power Co., made by connecting in one continuous circuit its 3-phase transmission lines between Seattle, Tacoma, and the Falls. 700 w. Eng Rec—Dec. 15, 1900. No. 38181.

**Wisconsin.**

Apple River Water Power Transmission. Walter S. Morton. Brief illus-

trated description of the plant which utilizes the power of a waterfall in Wisconsin. 600 w. Elec Wld & Engr—Dec. 8, 1900. No. 38128.

### MISCELLANY.

**Code.**

The National Electrical Code. B. H. Glover. Read before the electrical engineering department of Armour Inst. Discusses the rules and requirements, and considers the stages through which they have passed. 2500 w. W Elect'n—Dec. 15, 1900. No. 38186.

**Education.**

Electrical Engineering at McGill University, Montreal, Canada. Charles T. Child. Illustrates and describes the equipment and facilities. 5600 w. Elec Rev, N. Y.—Dec. 12, 1900. No. 38160.

**Exposition.**

Electrotechnics at the Paris Exposition, 1900 (Die Elektrotechnik auf der Pariser Weehausstellung, 1900). Dr. F. Vogel. A general descriptive address delivered before the German Society of Mechanical Engineers. 2500 w. Glaser's Annalen—Nov. 15, 1900. No. 38336 D.

**Prices.**

The 4-C Method of Charging for Electric Current. Ralph J. Patterson. Discusses methods of selling current. 1700 w. Am Elect'n—Dec., 1900. No. 38071.

## GAS ENGINEERING

**Acetylene.**

Acetylene in Germany. Reviews the report of Dr. Rose, British Consul at Stuttgart, concerning the use of acetylene. 1800 w. Engr, Lond—Dec. 14, 1900. No. 38263 A.

**Ammonia.**

Ammoniacal Liquor as a Manure. G. Abbey, in the *Journal of Horticulture*. Its value and how to use it. 1300 w. Gas Engs' Mag—Nov. 10, 1900. No. 38006 A.

The Valuation of Gas Liquor. F. J. R. Carulla. Abstract of a paper read before the Soc. of Chem. Ind., England, giving a description of the method of testing ammoniacal liquor. 1800 w. Jour Gas Lgt—Dec. 4, 1900. No. 38150 A.

**Carbide.**

See Electrical Engineering, Electrochemistry.

**Carbonic Oxide.**

The Determination of Carbonic Oxide in Gas. Translated account of a new method recently described in German papers. 1300 w. Jour Gas Lgt—Dec. 11, 1900. No. 38245 A.

**Combustion.**

The Products of Combustion of Various Lighting Apparatus (Les Produits de Combustion de Divers Appareils d'Eclairage). N. Gréhant. Especially comparing the products of combustion of the Argand and the Welsbach burners. 1000 w. Comptes Rendus—Dec. 3, 1900. No. 38335 D.

**Consumption.**

Effect of Quality on the Consumption of Gas. W. J. Dibdin. Abstract of a paper and discussion at meeting of the London section of the Soc. of Chem. Ind. Reports the results of experiments made. 4800 w. Gas Wld—Dec. 8, 1900. No. 38217 A.

Mr. Dibdin on the Effect of Quality on the Consumption of Coal Gas, with Some Remarks as to the Results of Adding Water Gas to Coal Gas. Review of a paper read before the Soc. of Chem. Ind., England. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38149 A.

**Gas Engines.**

See Mechanical Engineering, Special Motors.

**Gasholders.**

Holders at the Birmingham Gas-Works. Describes the enlargement of a gasholder, and gives illustrations of the construction of a new holder, to be described. 1800 w. Engr, Lond—Dec. 7, 1900. Serial. 1st part. No. 38204 A.

**Gas Industry.**

The Future of the Gas Profession. Reviews the subject, indicating some directions in which to look for improvement. 3000 w. Jour Gas Lgt—Dec. 11, 1900. Serial. 1st part. No. 38244 A.

**Gas Mixtures.**

The Supply of Mixtures of Coal Gas and Water Gas. H. Bunte. Abstract translation of a communication to the German Assn. of Gas and Water Engs. Discusses the production and distribution of a mixture of coal gas and water gas, or carburetted water gas. 6000 w. Jour Gas Lgt—Nov. 27, 1900. No. 38091 A.

**Mains.**

What Is the Maximum Delivering Capacity of Mains? Observations on gas distribution at high pressure and the views recently advanced by various authorities. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38147 A.

**Meters.**

Automatic Meters. Thomas Lighboy. Reviews the history of slot-meters and compares the price charged for gas consumed by slot and ordinary consumers. 2300 w. Gas Engs' Mag—Nov. 10, 1900. No. 38005 A.

**Supply.**

Public Gas Supply. Alton D. Adams. Discusses the heating power of illuminating gas and makes comparison with the heating power of coal; also discusses the growing use of gas engines as a source of power, cost, etc. 1800 w. Munic Engng—Dec., 1900. No. 37987 C.

**Tar and Ammonia.**

Professor Lunge on Coal Tar and Ammonia. A review of the third and enlarged edition of a work by George Lunge. 1800 w. Jour Gas Lgt—Nov. 27, 1900. No. 38090 A.

**Water Gas.**

Benzolized Water Gas at Erfurt. Photographic views of the plant, with plan and elevations, and description of the system of working adopted. 3000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38146 A.

**Welsbach.**

The Welsbach Light. Report of the Franklin Inst., through its committee on Science and the Arts, on the exhibit of the Welsbach Light Co., of Gloucester City, N. J. 3000 w. Jour Fr Inst—Dec., 1900. No. 38063 D.

## MARINE AND NAVAL ENGINEERING

**Accident.**

Smashup of the Starboard Engines of the American Liner "St. Paul." An account of the accident during the last westward trip, so far as now known. Ill. 1000 w. Marine Engng—Dec., 1900. No. 38158 C.

**Battleships.**

Contract Trial of the United States Battleship "Wisconsin." J. K. Robison. Illustration and description of the vessel and its equipment, with full report of the official trial. 2400 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38133 H.

Contract Trial of the United States Sea-going Battleship "Alabama." H. Hall. Illustrated detailed description of the vessel and its equipment, with report of the trial. 6500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38130 H.

Russian First-Class Battleships—"Borodino" Class. Illustrates and describes a vessel as a type of Russia's standard battleship. 1100 w. Engr, Lond—Nov. 30, 1900. No. 38116 A.

The First-Class Battleship "Wisconsin." Brief description, with illustrations. 1200 w. Sci Am—Dec. 8, 1900. No. 38049.

**Boiler Test.**

See Mechanical Engineering, Steam Engineering.

**Coal Consumption.**

Coal-Consumption Tests of S. S. "John W. Gates." B. C. Bryan. The object of the tests described was to note the action of and results obtained using the Crowe Patent Stoker. 2500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38132 H.

**Cruisers.**

Speed Trials of the "Variag." An account of the contract performance, which exceeded the requirements by ¼ knot, maintaining a speed of 23¼ knots for twelve consecutive hours, under natural draft. Ill. 1500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38134 H.

The New Armored Cruisers of the "California" and "Maryland" Types. Illustrated description of the vessels and their equipment, with favorable comments. 1500 w. Sci Am—Dec. 1, 1900. No. 37952.

**"Deutschland."**

The Hamburg-American Atlantic Liner "Deutschland." A review of the progress in shipbuilding as typified by this vessel, with illustrated description of the machinery. 3000 w. Engng—Nov. 23, 1900. Serial. 1st part. No. 37994 A.

**Engineers.**

Naval Engineers. Editorial on the report of Rear-Admiral Melville of the United States Bureau of Steam Engineering. 2500 w. Engng—Dec. 7, 1900. No. 38193 A.

**Gun.**

The New American 16-inch Gun (A Propos du Nouveau Canon Américain de 16 Pouces). A discussion of the probable range of the new gun, computing its maximum to be only about 14 miles, instead of nearly 24 miles, as computed by Major Ingalls. 2000 w. Revue Technique —Nov. 25, 1900. No. 38322 D.

**Lake Steamer.**

New Foreign-Built Lake Steamer. Illustration, with description, of the new British-built steamship "Donnacona," constructed on the American plan and intended for service on the Great Lakes. 1200 w. Naut Gaz—Nov. 29, 1900. No. 38023.

**Loading.**

Electric Freight Conveyors for Loading and Unloading Vessels. Illustrated description of the McCabe electric conveyor. 600 w. Sci Am—Dec. 15, 1900. No. 38139.

**Naval Proving Grounds.**

United States Naval Proving Ground, Indian Head. Jos. Strauss. Illustrates and describes the grounds and the testing work. 1800 w. Sci Am—Dec. 29, 1900. No. 38280.

**Propulsion.**

See Electrical Engineering, Power Applications.

**Shipbuilding.**

Expansion of the Cramps. Statement of Charles H. Cramp concerning the plans of his company. Will probably add armor and armament to their plant. 1400 w. Marine Rev—Dec. 13, 1900. No. 38175.

The Cost of Shipbuilding in America. Editorial discussing the Subsidy Bill before the U. S. Congress. 1600 w. Engr, Lond—Dec. 14. 1900. No. 38267 A.

**Shipping Bill.**

Senator Frye's Speech. In the presentation of the shipping bill to the U. S. Senate. 3200 w. Marine Rev—Dec. 13, 1900. No. 38176.

Senator Hanna on the Shipping Bill. Discusses the American merchant marine and the cause of its decline, and the benefits the bill will bring to industry. 5500 w. Marine Rev—Dec. 20, 1900. No. 38416.

Subsidies for American Merchant Vessels. Editorial discussion of the ship-subsidy bill now pending in the U. S. Congress. 2500 w. Eng News—Dec. 20, 1900. No. 38230.

The Ship Subsidy Bill. States the position of the advocates of the bill, and of the opposition, and discusses its chances. 1600 w. Ir Age—Dec. 13, 1900. No. 38136.

The Ship Subsidy Bill. Considers the outlook for the measure now before the U. S. Senate. 1900 w. Ir Age—Dec. 27, 1900. No. 38275.

**Steamship.**

Fine New Steamship. Illustration and description of the "James S. Whitney," one of the most perfect freighters on the Atlantic Coast. 2500 w. Naut Gaz—Dec. 13, 1900. No. 38197.

Red Star Liner "Vaderland." Illustrated description of the vessel and equipment. 2400 w. Marine Rev—Dec. 27, 1900. No. 38449.

**Steamship Contract.**

Nicaraguan Steamship Contract. Translation of the contract between the government and Mr. Joseph Frye, representing the United States Fruit Co., of Boston, Mass., for the establishment of a line of steamers. 1800 w. U. S. Cons Repts, No. 912—Dec. 17, 1900. No. 38195 D.

**Submarine.**

Submarine Navigation. W. P. Bradley. An account of the development of submarine navigation, giving illustrated descriptions of vessels of particular interest, and discussing their value in coast protection and in warfare. 5700 w. Pop Sci M—Dec., 1900. No. 37975 C.

The Submarine Boat and Its Future. John P. Holland. An account of what may be expected of submarine boats in warfare and in peace. 4300 w. N Am Rev—Dec., 1900. No. 38017 D.

**Tender.**

Class "A" Tender of the German Navy (Dampf-Beiboot Kl. A. der Kaiserlichen Marine). Giving the lines, sections, and powering of the standard German naval tender. 2000 w. Schiffbau—Nov. 23, 1900. No. 38347 D.

**Warships.**

Warship Construction in 1900. Facts relating to British naval activity. 2500 w. Engng—Dec. 21, 1900. Serial. 1st part. No. 38464 A.

# MECHANICAL ENGINEERING

## AUTOMOBILISM.

**Accumulator.**

The Lee-Coll Accumulator. Illustrated detailed account of this new accumulator for use with automobiles. 1600 w. Auto Jour—Dec., 1900. No. 38408 A.

**Auto-Car Trials.**

Notes on the Electric Auto Car Trial. Merwin O'Gorman. Remarks on facts developed by these trials, and information of interest. 3300 w. Elect'n, Lond—Nov. 23, 1900. No. 38008 A.

**Battery Cases.**

On the Construction of Battery Cases in Electric Vehicles. Translation of article by Dr. Ernst Andreas in *Centralblatt fuer Accumulatoren-und-Elementenkunde.* 2000 w. Horseless Age—Dec. 26, 1900. No. 38278.

**Brakes.**

Brakes. P. M. Heldt. Discusses how many to use, and how to make them effective for both directions of motion, as applied to motor vehicles. Ill. 1400 w. Horseless Age—Dec. 12, 1900. No. 38156.

**Commercial Vehicles.**

Commercial Automobile Vehicles. George E. Walsh. Reviews the present condition and future outlook for this class of vehicles. 1300 w. W Elect'n—Dec. 22, 1900. No. 38251.

**Compounding.**

Compounding Vehicle Gasoline Engines. C. P. Malcolm. Considers the advantages and disadvantages of a compound construction, and describes the simplest form of construction for a three-cylinder compound engine. 1600 w. Horseless Age—Dec. 5, 1900. No. 38092.

**Dog-Cart.**

The Electric Motive Power Company's Dog-Cart. Illustrates and describes the dog-cart which took part in the recent trials at Chislehurst. 1500 w. Auto Jour—Dec., 1900. No. 38410 A.

**Driving Power.**

The Driving Power. E. J. Stoddard. Mathematical. 1500 w. Horseless Age—Dec. 5, 1900. No. 38093.

**Electric Car.**

The Electric Motor-Car Problem. Reviews ideas advanced by Dr. Luxenberg, in an article in *Centralblatt für Accumulatoren und Elementenkunde*. 1400 w. Elec Rev, Lond—Nov. 30, 1900. No. 38102 A.

**Electric Wagon.**

The Pastel-Vinay Electric Wagon. Details and drawings of a vehicle constructed for the Say Sugar Refinery in Paris. 900 w. Auto Jour—Dec., 1900. No. 38409 A.

**Exhibits.**

Automobiles at the Paris Exposition (Die Weltausstellung in Paris, 1900; die Automobilen). Dr. E. Müllendorff. A general review, noting the especial features of novelty among the exhibits. 2500 w. Glaser's Annalen—Dec. 1, 1900. No. 38326 D.

**Feed Water.**

Water for Automobile Boilers. E. J. Stoddard. A discussion of the subject from the engineer's standpoint, giving tests of waters. 1200 w. Horseless Age—Dec. 26, 1900. No. 38277.

**Gasoline Vehicle.**

The Schaudel Motor Vehicle. An illustrated detailed description, from *La France Automobile*. 3200 w. Horseless Age—Dec. 19, 1900. No. 38223.

**Gears.**

Gearing. E. C. Oliver. Information concerning the systems, strength of gears, etc., intended for those interested in the design and construction of automobiles. Ill. 2400 w. Horseless Age—Dec. 19, 1900. No. 38222.

**Heavy Traffic.**

Heavy Motor Traffic in France. Georges Forestier. Address before the Liverpool Self-Propelled Traffic Assn. A general review of automobilism in France, and closely related topics. 11200 w. Auto Jour—Dec., 1900. No. 38411 A.

**Liquid Air.**

Liquid Air Automobile. Brief illustrated description of a novelty exhibited at the Automobile Show in New York. 700 w. Sci Am—Dec. 1, 1900. No. 37951.

**Pavements.**

See Civil Engineering—Municipal.

**Steam Vehicles.**

The Automobile Manufacturing Company's New Steam Carriage. Illustrated description of an entirely different system from any hitherto on the market, and the latest design. 3000 w. Auto Jour—Dec., 1900. No. 38407 A.

The Serpollet Steam Automobile. An illustrated description of this system and the mechanism employed. 1700 w. Sci Am—Dec. 8, 1900. No. 38048.

**Traction.**

Road Traction. H. S. Hele-Shaw. On past investigations of traction resistance, and the needed study of the causes of resistance for self-controlled vehicles, with suggestions. Also general discussion. Ill. 6000 w. Jour Soc of Arts—Dec. 7, 1900. No. 38200 A.

**Wheels.**

The Design of Wheels. Editorial on the importance of the wheel as an invention, and the new problems arising in the manufacture of self-propelled vehicles. 2600 w. Eng News—Dec. 6, 1900. No. 38080.

## HYDRAULICS.

**Air Chambers.**

Comparative Value of Different Arrangements of Suction Air Chambers on Pumps. F. Meriam Wheeler. An illustrated article showing the importance of properly locating a suction air chamber on a pump. 1500 w. Trans Am Soc of Mech Engs—Dec., 1900. No. 38208 C.

**Pumps.**

Notes on the Construction and Working of Pumps. Edward C. R. Marks. Part first considers certain laws and conditions applicable to the working of pumping machinery in general. Ill. 2000 w. Prac Engr—Dec. 7, 1900. Serial. 1st part. No. 38219 A.

**Pumping Engine.**

An Accident to a Faithful Servant. Illustrated description of a Cornish pumping engine in use since 1857 at the Cleveland water-works, with notes concerning its efficiency. 1500 w. Eng Rec—Dec. 29, 1900. No. 38420.

**Tanks.**

Improved Forms for Tanks (Neuere Formen für Flüssigkeitsbehälter). G. Barkhausen. With especial reference to various curved forms of bottoms for tanks, so arranged as to equilibrate opposing stresses. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 24, Dec. 8, 1900. No. 38216 each D.

**Turbines.**

Testing the Capacity of Turbines. Edward P. Burch. Résumé of a test recently made for the St. Anthony Falls Water Power Co., of Minneapolis. 1600 w. Elec Wld & Engr—Dec. 22, 1900. No. 38241.

## MACHINE WORKS AND FOUNDRIES.

**Armstrong.**

Lord Armstrong and the Elswick Works. Benjamin Taylor. A description of the growth and present condition of the Armstrong works at Elswick as an example of successful Works Management. 3500 w. Engineering Magazine—Jan., 1901. No. 38368 B.

**Carnegie.**

The Huge Enterprises Built up by Andrew Carnegie. Chas. M. Schwab. A study of the Carnegie works as illustrative of the methods of one of the foremost industrial managers. 4000 w. Engineering Magazine—Jan., 1901. No. 38369 B.

**Casting Machine.**

The Ramsay Casting and Conveying Machine. Illustrated detailed description. 2000 w. Ir Trd Rev—Dec. 13, 1900. No. 38174.

**Castings.**

Scabs and Buckles—Their Cause and Effect. Edward B. Gilmour. Explains the terms as applied to castings, and discusses the erroneous views held and the true cause. 1000 w. Foundry—Dec., 1900. No. 37992.

**Cost Keeping.**

Cost Keeping: A Subject of Fundamental Importance. J. N. Gunn. A discussion of the fundamental principles essential to the establishment of a satisfactory system, with especial reference to engineering works. 3000 w. Engineering Magazine—Jan., 1901. No. 38382 B.

**Crane.**

Twenty Ton Electric Crane at the Paris Exposition (Der 20 Tonnen Elektrische Laufkrahn auf der Weltausstellung in Paris). Todor Kende. A general description of the electric crane built by Ganz & Co., of Budapest. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver —Nov. 30, 1900. No. 38312 B.

**Depreciation.**

The Radical Policy of Scrapping Costly Machinery. H. F. J. Porter. A striking review of the drastic methods of American managers in throwing aside costly machines so soon as improved devices appear. An exposition of the contrast between English and American methods. 4500 w. Engineering Magazine—Jan., 1901. No. 38386 B.

**Dies.**

Binding and Forming Dies for Round Work. Joseph V. Woodworth. Illustrates and describes circular binding and forming dies and the methods of using them. 900 w. Am Mach—Dec. 13, 1900. No. 38152.

**Electric Driving..**

Applications of Electric Power in Engineering Works. Dr. Louis Bell. A broad discussion of the changes wrought by the distribution of electric energy in engineering works and its influence upon the arrangement and design of establishments. 4000 w. Engineering Magazine—Jan., 1900. No. 38385 B.

**Facing.**

Developing a Manhole Facing Machine. H. P. G. Norstrand. Illustrated description of a machine designed to face off the flanges of elliptical shaped manhole openings. 800 w. Am Mach—Dec. 13, 1900. No. 38155.

**Foundry Practice.**

A Survey of Modern Foundry Practice. Percy Longmuir. Showing the defects of many of the older foundries and the remarkable cheapening in castings effected by the introduction of modern methods and machines. 5000 w. Engineering Magazine—Jan., 1901. No. 38379 B.

The Empress Foundry, Manchester. Illustrated description of new English works. 1500 w. Engr, Lond—Dec. 7, 1900. No. 38205 A.

The Westinghouse Machine Company. An illustrated detailed description of the foundry of this company, located at East Pittsburg, Pa., and the castings made there. 3000 w. Foundry—Dec., 1900. No. 37991.

**Gearing.**

Some Tricks in Spacing Gear Teeth—Spacing for Prime Numbers of Teeth by a Jack-in-the-Box Mechanism. A. L. de Leeuw. Illustrated description of methods. 2800 w. Am Mach—Dec. 6, 1900. No. 38067.

**Hoisting.**

Notes on Hoisting Drums. C. F. Blake. Illustrated suggestions concerning the design of hoisting drums. 500 w. Am Mach—Dec. 13, 1900. No. 38151.

**Intensified Production.**

Intensified Production and Its Influence Upon the Worker. M. P. Higgins. An argument to show that the use of modern automatic machinery does not act to degrade and injure the workman, but that the contrary is the real effect. 4000 w. Engineering Magazine—Jan., 1901. No. 38374 B.

**Krupp.**

The Founders of the Krupp Establishments. E. Schroedter. A historical review of the development of the great Krupp works, showing the results of skilled industrial management and organization. 3500 w. Engineering Magazine—Jan., 1901. No. 38370 B.

**Labor Management.**

Altruism and Sympathy as Factors in Works Administration. J. H. Patterson. Giving numerous examples of the manner in which the comfort and happiness of employees are considered in well-known establishments in Europe and America. 3500 w. Engineering Magazine—Jan., 1901. No. 38375 B.

**Lathe.**

A New Elliptical Lathe. C. W. MacCord. Illustrates and describes a lathe for elliptical turning, possessing novel features. 1800 w. Sci Am Sup—Dec. 15, 1900. No. 38141.

**Machine Tools.**

Machine Tools at the National Show. Illustrated description of interesting exhibits. 3400 w. Engng—Dec. 7, 1900. No. 38192 A.

Machine Tools at the Stanley Show. Illustrated description of interesting exhibits. 5000 w. Engng—Nov. 30, 1900. No. 38111 A.

Notes Taken on the Manufacture of Machine Tools at the Shops of Prentice Bros. Company, Worcester, Mass. Ill. 3500 w. Mach, N. Y.—Dec., 1900. No. 38056.

Some Continental Machine Tools. An illustrated study of these tools as presented at the Paris Exhibition. 15600 w. Engr, Lond—Nov. 23, 1900. No. 37999 A.

**Milling Machines.**

Milling Machine Heads at Paris. Notes certain features of design which have for their object the adaptation of the milling spindle to work at various angles. Ill. 2000 w. Engng—Dec. 21, 1900. No. 38461 A.

**Molding.**

Molding a Casting by Bedding in the Floor. R. H. Palmer. An illustrated description of this method and a statement of some of the advantages. 1300 w. Am Mach—Dec. 6, 1900. No. 38069.

Molding a Fly-wheel. Illustrated description of the method used. 800 w. Am Mach—Dec. 27, 1900. No. 38414.

Molding a Gas Engine Bed in a Three-Part Flask. R. H. Palmer. Illustrated description of the method used. 1200 w. Am Mach—Dec. 13, 1900. No. 38153.

**Organization.**

The Old Trades Unionism vs. Wisely Organized Labor. George N. Barnes. A review of the relations of employers and employees in Great Britain, by the Secretary of the Amalgamated Society of Engineers. 3500 w. Engineering Magazine—Jan., 1901. No. 38373 B.

What Employers May Prevent and Effect by United Action. Sir B. C. Browne. A discussion of the uses and abuses of organization among employers and employees from the standpoint of the Employers' Federation. 3000 w. Engineering Magazine—Jan., 1901. No. 38372 B.

**Paris Exhibition.**

Cast, Forged, and Flanged Work at Paris. A review of exhibits. Ill. 3200 w. Engng—Dec. 7, 1900. No. 38190 A.

**Pattern Making.**

Pipe Work. John M. Richardson. Illustrates examples often needed for special work which must be prepared at a minimum of time and expense, giving one way of accomplishing the result. 700 w. Am Mach—Dec. 13, 1900. No. 38154.

**Petroleum Furnace.**

A Convenient Petroleum Furnace. An illustrated description of an economical apparatus for ordinary forge work used by Russians. 1400 w. Am Mfr—Dec. 6, 1900. No. 38094.

**Piece Work.**

The Taylor Differential Piece-Rate System. Sanford E. Thompson. An exposition of the method of fixing piece rates which has proved so successful in large establishments in the United States. 5000 w. Engineering Magazine—Jan., 1901. No. 38377 B.

**Pneumatic Tool.**

The Boyer Long-Stroke Pneumatic Hammer. Illustrated detailed description. 2000 w. Engng—Dec. 14, 1900. No. 38269 A.

**Premium Plan.**

The Premium Plan of Labor Remuneration. H. M. Norris. An account of the practical working of the premium system as it exists under the immediate supervision of the writer. 4000 w. Engineering Magazine—Jan., 1901. No. 38378 B.

**Repairing.**

Patching a Large Hydraulic Press Table. A. F. Horton. An illustrated description of difficult repairing. 1100 w. Am Mach—Dec. 20, 1900. No. 38225.

**Rivets.**

The Flow of Metal Exemplified by a Rivet. George S. Hodgins. An interesting explanation of what takes place in the setting of a good tight rivet. Ill. 1700 w. Loc Engng—Dec., 1900. No. 37969 C.

**Screw Threads.**

A Couple of Mechanical Paradoxes. C. C. Stutz. Illustrates the practical application of peculiar mechanical principles in the cutting of screw threads. 1600 w. Mach. N. Y.—Dec., 1900. No. 38057.

**Shop Arrangement.**

Shop Arrangement as a Factor in Efficiency. H. F. L. Orcutt. A discussion of the design of an engineering works as a great tool, by the designer of the works of Ludwig Loewe & Co., of Berlin. 3000 w. Engineering Magazine—Jan., 1901. No. 38384 B.

**Shot Iron.**

Recovery and Use of Shot Iron. E. H. Putnam. Prepared for the Dec. meeting of the Foundrymen's Assn. Explains how success was attained in using this class of iron, and the value of the magnetic separator. 1500 w. Ir Trd Rev—Dec. 6, 1900. No. 38062.

**Specialization.**

The Mechanical and Commercial Limits of Specialization. J. Slater Lewis. An examination of the natural and artificial conditions favoring the question of specialization in manufactures, with arguments for and against it. 3500 w. Engineering Magazine—Jan., 1901. No. 38383 B.

**Westinghouse.**

George Westinghouse—Inventor, Organizer, and Director. Walter M. McFarland. Describing the methods which have so successfully built up the great and varied Westinghouse interests. 4000 w. Engineering Magazine—Jan., 1901. No. 38371 B.

## MATERIALS OF CONSTRUCTION.

**Bronzes.**

The Aluminum Bronzes. From the *Aluminum World*. Some points on the making of this material and the uses for which it is adapted. 1700 w. Foundry—Dec., 1900. No. 37993.

**Cast Iron.**

See Mining and Metallurgy, Iron and Steel.

**Expanded Metal.**

Expanded Metal and Some of the Uses to Which It Is Put. James S. Merritt. Describes the manufacture and the various grades, and gives many interesting uses of this material. 3700 w. Jour Fr Inst—Dec., 1900. No. 38065 D.

**Sawing.**

Lines Produced in the Sawing of Metals (Lignes Superficielles Apparaissant dans le Sciage des Métaux). Ch. Frémont. An examination of the markings of sawed metallic surfaces, with reference to other marks than those produced by the saw. 1000 w. Comptes Rendus—Nov. 12, 1900. No. 38333 B.

**Tests.**

Some Recent Tests of American Iron and Steel. J. Walter Esterline and Robert B. Treat. Tests made of a large number of samples to determine the variation in magnetic quality, with results. 1200 w. Elec Wld & Engr—Dec. 22, 1900. No. 38242.

## POWER AND TRANSMISSION.

**Brakes.**

Brakes for Electric Cranes. Information concerning recent practice in electric brakes. 3400 w. Engr, Lond—Nov. 30, 1900. No. 38114 A.

**Compressed Air.**

An Air Compressor Plant for Field Riveting. Illustrated description of a 2-stage compressor on top of a horizontal receiver, the whole carried on the same skids that support the boiler. 500 w. Eng Rec—Dec. 1, 1900. No. 37944.

**Connecting Rod.**

The Stress Produced in a Connecting Rod by Its Motion. C. H. Innes. Read before the N. E. Coast Inst. of Engs. & Shipbuilders. Shows the method of mathematically computing the stress. 1100 w. Engs' Gaz—Dec., 1900. No. 38106 A.

**Friction.**

A Theoretical and Experimental Study of the Internal Friction of Lubricants (Etude Théorique et Expérimentale sur le Frottement Médiat). N. Petroff. A paper presented before the Institute of Technology of St. Petersburg, with much valuable information on the action of lubricants. 12000 w. Revue de Mécanique—Nov., 1900. No. 38320 H.

**Loading.**

See Marine and Naval Engineering.

**Power Plants.**

The Great Northern Paper Company's New Mill. Illustrated description of the Millinocket Mills, having a daily capacity of 400 tons of paper; the works include a large hydraulic power plant, a steam plant, mechanical and sulphite pulp mills, and a paper-making plant. All novel arrangements and fully explained. 4700 w. Eng Rec—Dec. 15, 1900. No. 38178.

**Shafts.**

Some Reasons for Making Hollow Shafts. H. F. J. Porter. Answers to

questions relating to this subject. 1000 w. Am Mach—Dec. 6, 1900. No. 38068.

**Transmission.**

Transmission of Gas and Air Through Pipes and the Transmission of Power by Compressed Air. Frederick W. Gordon. Considers the compression, transmission and expansion. General discussion. Ill. 3400 w. Pro Engs' Club of Phila—Nov., 1900. No. 38020 D.

## SPECIAL MOTORS.

**Gas Engines.**

Engines for the Utilization of Blast Furnace Gases. Considers the different types of gas motors, von Oechellhaueser's system, and compares the different systems. Ill. 4300 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38454 A.

One-Horse-Power Gas Engine. George H. Johnston. Design and drawings for the construction of a small gas or gasoline engine, with explanatory notes. 1700 w. Horseless Age—Nov. 28, 1900. No. 37962.

Gas Engines and Electric Power Plants. Reviews the series of articles published in *Engineering* by Philip Dawson, relating to the use of gas engines in connection with electric power plants. 1100 w. Jour Gas Lgt—Dec. 11, 1900. Serial. 1st part. No. 38243 A.

Power-Gas and Large Gas-Engines for Central Stations. Herbert A. Humphrey. Discusses gas engines, their economy as compared with steam engines, their reliability, etc., and gives appendices containing information of interest. Ill. 9800 w. Inst of Mech Engs—Dec. 14, 1900. No. 38440 D.

The Oechelhaueser Blast Furnace Gas Engine. Abstract of address by A. Wagenen, describing the principal features of this engine. Ill. 1500 w. Ir Age—Dec. 6, 1900. No. 38051.

The Use of Blast Furnace Gases in Gas Engines. Joseph W. Richards. A discussion of the great economy that may be made by applying this improvement, citing many cases, and reviewing the history of investigations made. 4500 w. Jour Fr Inst—Dec., 1900. No. 38064 D.

Why Compounding Gas Engines Failed. H. J. Podlesak. Reviews the attempts made to compound gas and gasoline engines. 1500 w. Mod Mach—Dec., 1900. No. 38052.

**Lubrication.**

Piston Lubrication of Internal Heat Engines. Hugh D. Meier. Considers the two distinct systems employed and the advantages of each. 2800 w. Horseless Age—Dec. 26, 1900. No. 38276.

## STEAM ENGINEERING.

**Boiler Pressure.**

High vs. Low Boiler Pressure. Alfred Siebert. Advantages of low pressure for heating; the difference when used for power purposes; and the influence of cylinder condensation. 1700 w. Ice & Refrig—Dec., 1900. No. 38021 C.

**Boiler Test.**

Test of One of the Babcock & Wilcox Boilers for the "Cincinnati." Gives a description of the boiler and appurtenances and of the object of the tests and apparatus, with the results. Ill. 2000 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38131 H.

**Calorimeter.**

A New Form of Calorimeter for Measuring the Wetness of Steam. John Goodman. Read at Bradford meeting of the British Assn. Illustrates and describes an instrument designed by the author, and also the method of using it. 2000 w. Gas Engs' Mag—Nov. 10, 1900. No. 38004 A.

**Chimney.**

See Architectural Engineering—Construction.

**Corrosion.**

Internal Corrosion in Steam Boilers. M. P. Bonet. Presented at Paris Congress. Discusses pitting, corrosion by hydrochloric acid or chlorides, by sulphuric acid, by tannic acid, by grease, by sugar, and by mechanical action. 6300 w. Power—Dec., 1900. No. 38168.

**Engine Builders.**

Papers Read at the Annual Meeting of the Engine Builders' Association. Official abstracts of papers by H. C. Ebert, H. G. Reist, and E. J. Armstrong. 5300 w. Eng News—Dec. 20, 1900. No. 38227.

**Feed Water.**

See Mechanical Engineering, Automobilism.

**Fuels.**

See Mining & Metallurgy, Coal and Coke.

**Indicators.**

Cut-off in Indicator Work. G. W. Wildin. Suggestions from the writer's experience in indicator work. 1400 w. Loc Engng—Dec., 1900. No. 37971 C.

**Mechanical Draft.**

The Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Presented at meeting of the N. Eng. Cotton Mfrs.' Assn. Illustrated paper dealing with cost, expense of maintenance and operation, methods of application, etc. 4000 w. Power—Dec., 1900. No. 38170.

**Meter.**

The Gehre Steam Meter (Der Dampfmesser von Gehre). L. C. Wolff. The apparatus acts by recording the difference in pressure upon two sides of a contracted passage, giving the flow at any instant and the total quantity in a given period. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 8, 1900. No. 38319 D.

**Pipes.**

Pipe Bends in the Power Plant. Illustrated discussion of the advantages of the use of bends in place of elbows. 3200 w. Power—Dec., 1900. No. 38171.

**Powdered Coal.**

Burning Powdered Coal in Stationary Boilers. Illustrated description of apparatus in a Brooklyn machine shop, with tests of its operation. 1000 w. Eng Rec—Dec. 29, 1900. No. 38422.

**Smoke Prevention.**

The Possibilities of Electrical Smoke Deposition. J. Wright. Recalls some early experiments in this direction, as given in a paper by Prof. Lodge, and offers suggestions. 1200 w. Elec Rev, Lond—Nov. 23, 1900. No. 38012 A.

**Steam Power.**

The Relation of the Steam Engine to Modern Economic Production. F. R. Hutton. A critical examination of the influence of the development of steam power upon the industrial problems of the day, with especial relation to the subject of works management. 3500 w. Engineering Magazine—Jan., 1901. No. 38376 B.

**Tube Cleaners.**

Boiler Tube Scrapers and Brushes. James F. Hobart. Brief illustrated descriptions of various types. 1200 w. Am Elect'n—Dec., 1900. No. 38077.

**Turbines.**

Steam Turbines. Francis Hodgkinson. Discusses in detail this branch of steam engineering. Ill. 8200 w. Am Mfr—Dec. 20, 1900. No. 38249.

### MISCELLANY.

**Airship.**

The Roze Dirigible Airships. Illustrated description of an interesting type being constructed in the vicinity of Paris. 1300 w. Sci Am—Dec. 22, 1900. No. 38226.

**Card Index.**

Engineering Periodicals, and the Card Index. H. Wade Hibbard. Presented before the Cornell Soc. of Mech. Engs. On the value of trade papers and of the card index. 4700 w. Sib Jour of Engng—Dec., 1900. No. 38187 C.

**Cold Storage.**

The Cold-Storage Plant of the Brussels Markets (Frigorifère des Halles Centrales de Bruxelles). Leon Ducuroir. A full account of the ammonia refrigerating plant on the Fixary system, in successful operation at Brussels for the preservation of market material and the production of ice. 7500 w. 2 plates. Rev Univ des Mines—Nov., 1900. No. 38340 H.

**Combinations.**

The Strength and Weakness of the Combination or Trust Idea. A symposium of the opinions of Messrs. John D. Rockefeller, Andrew Carnegie, J. B. Dill, and the late Lord Russell; with editorial comments. 4500 w. Engineering Magazine—Jan., 1901. No. 38388 B.

**Mechanical Progress.**

Chronology of the Nineteenth Century. A record of mechanical progress during the past one hundred years, reviewing the important events in the development of machinery, chiefly in the United States, and to some extent in other countries. 18700 w. Mach, N. Y.—Dec., 1900. No. 38058.

**Ordnance.**

The Development of the Krupp Field Artillery Material. Illustrated notes on the material and construction of ordnance. 5800 w. Jour U. S. Art—Nov.-Dec., 1900. Serial. 1st part. No. 38196 D.

**Paper Making.**

The Paper Industry at the Exposition of 1900 (L'Industrie du Papier à l'Exposition de 1900). H. de la Coux. A general account of the machines for preparing the pulp, as well as those for the manufacture and finishing of paper, as shown at the Exposition. Two articles, 4000 w. Génie Civil—Nov. 17, 24, 1900. No. 38301 each D.

# MINING AND METALLURGY

### COAL AND COKE.

**Australia.**

The Coalfields of Western Australia. Information from a bulletin of the Geol. Survey of W. Aust., with maps. 1600 w. Col Guard—Nov. 30, 1900. No. 38122 A.

**Briquettes.**

American Coal Briquettes. Information concerning the methods of manufacture in America as compared with European practice; the advantages, etc. 1800 w. Sci Am—Dec. 8, 1900. No. 38047.

Briquettes as Steam Fuel. Reviews the early attempts at making briquettes, and reports tests made with various fuels. 2200 w. Ir & Coal Trds Rev—Dec. 7, 1900. No. 38202 A.

**By-Products.**

By-Product Coke Ovens. George Blake-Walker. A paper contributed to the Inst. of Civ. Engs., England. Considers the attempts made to recover the products, the design of by-product coke-ovens, etc. Ill. 2300 w. Col Guard—Dec. 7, 1900. Serial. 1st part. No. 38206 A.

**Coalfields.**

Post-Carboniferous Coalfields. Calls attention to deposits belonging to more recent geological dates than the true carboniferous, and their economic importance. Ill. 3500 w. Col Guard—Dec. 21, 1900. Serial. 1st part. No. 38460 A.

**Coal Handling.**

Handling Anthracite Coal. Waldon Fawcett. Illustrates and describes the improved and economical methods now in use. 1900 w. Sci Am—Dec. 1, 1900. No. 37950.

**Coal Working.**

Modern Soft-Coal Mining and Handling in the United States. Henry Hale. Illustrated description of methods of mining and shipping. 1800 w. Sci Am—Dec. 15, 1900. No. 38138.

**Fuels.**

Relative Values of Fuels Used on the Pacific Coast. Irving C. Allen. A report of determinations made by the writer. Extract from a thesis prepared by the author. 1500 w. Min & Sci Pr—Dec. 8, 1900. No. 38159.

**India.**

Cheap Coal Mining in India. An account of the methods of mining, the miners and their cheap labor. 1900 w. Am Mfr—Nov. 28, 1900. No. 37956.

**Modern Mining.**

The Pittsburg & Buffalo Coal Company's Mines. Illustrates and describes mines, showing the great advances made in coal mining by machinery, handling the coal, haulage, etc. 2500 w. Eng & Min Jour—Dec. 22, 1900. No. 38247.

**Natal.**

The Coal Fields of Natal. William Taylor Heslop. Information concerning this South African coalfield, its collieries, etc. 1500 w. Am Gas Lgt Jour—Dec. 24, 1900. No. 38418.

**New Sinkings.**

Description of Sandwell New Sinkings, Warstone Fields, West Bromwich. H. C. Cole. Describes the pumping arrangements, boilers, sinking and hauling engines, etc. Ill. 1800 w. Ir & Coal Trds Rev—Nov. 23, 1900. No. 38001 A.

**Paris Exhibition.**

Douchy Colliery at the Paris Exhibition. An account of the exhibits made by this colliery and of its deposit, method of working, etc. 2500 w. Col Guard—Nov. 30, 1900. No. 38123 A.

Lievin Colliery at the Paris Exhibition. An account of the exhibits made by this company, the methods of mining practiced, etc. 5300 w. Col Guard—Nov. 23, 1900. No. 38002 A.

Roche-la-Molière and Firminy Collieries at the Paris Exhibition. Description of an interesting exhibit which obtained a grand prix. 5500 w. Col Guard—Dec. 14, 1900. No. 38403 A.

**Peat.**

Peat and Compressed Peat Fuel. Philip R. Bjorling. Describes natural and compressed peat, methods of obtaining and preparing it, etc. 4000 w. Col Guard—Nov. 30, 1900. Serial. 1st part. No. 38119 A.

**Philippines.**

Coal Fields of the Philippines. G. D. Rice. Facts in regard to their location, extent, quality of the coal, and the opportunities for profitable operation. 2700 w. Mines & Min—Dec., 1900. No. 38030 C.

**Sinkings.**

The Sandwell Park New Sinkings. H. C. Cole. Abstract of a paper contributed to the *Journal* of the British Society of Mining Students. Descriptive account. 1500 w. Col Guard—Dec. 7, 1900. No. 38207 A.

**Victoria.**

The Coal Deposits of Victoria. James Stirling. An account of the discovery and extent of the coal-bearing areas, the character of the coal, etc. Ill. 3300 w. Ir & Coal Trds Rev—Nov. 23, 1900. No. 38000 A.

## COPPER.

**Tasmania.**

Mining in Eastern Tasmania. H. Grant. Part first gives the history of the Echo Mine, yielding copper, gold and silver, but in small percentages. 1600 w. Aust-Min Stand—Oct. 25, 1900. Serial. 1st part. No. 38053 B.

## GOLD AND SILVER.

**Alaska.**

Some Experiences in the Nome District, Alaska. Barry Searles. Reviews the rush of the season of 1900 and the resulting conditions, giving information of the region, and the degree of success. 3200 w. Eng & Min Jour—Dec. 29, 1900. No. 38450.

**Australia.**

The Indicator Vein, Ballarat, Australia. T. A. Rickard. An illustrated description of this peculiar black seam traversing the bed-rock underlying the alluvial deposits, and found to be associated with rich bunches of gold ore. 2800 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38-437 D.

**British Columbia.**

Greenwood Mining Division, Boundary Creek District. W. M. Brewer. Information compiled from the last report of the Greenwood Board of Trade. 1500 w. Eng & Min Jour—Dec. 1, 1900. No. 38-038.

**Bryan Mill.**

The Bryan Mill as a Crusher and Amalgamator Compared with the Stamp Battery. E. A. H. Tays. Continued discussion. The writer's reply to A. H. P. Wynne's criticism. 2000 w. Trans Am Inst of Min Engs—Sept., 1899. No. 38-435 D.

**Dredging.**

A California Gold Dredger. R. H. Postlethwaite. Illustrated description of a dredger on the Feather River. 1200 w. Min & Sci Pr—Dec. 15, 1900. No. 38221.

Dredging for Gold. W. S. Russell. Facts in regard to the operation of dredges on placers at various places in the western part of the United States. Ill. 1800 w. Mines & Min—Dec., 1900. No. 38026 C.

Suggestions on Inland Gold Dredging. A. C. Eteson. Suggestions on the practical working of a dredger. Ill. 1000 w. Min & Sci Pr—Dec. 22, 1900. No. 38279.

**Milling.**

Stamp Milling of Free Gold Ores. Dana Harmon. Read before the Tech. Soc. of the Pacific Coast. A discussion of the fundamental principles of milling. Ill. 8500 w. Min & Sci Pr—Dec. 1, 1900. No. 38061.

The New Gold Mill at Republic, Washington. D. C. Jackling, in the *Republic Miner*. Description of the mill and arrangements for treating the ores. 1700 w. Eng & Min Jour—Dec. 1, 1900. No. 38-039.

**Philippines.**

Gold in the Philippines. F. F. Hilder. Information obtained during a recent visit to the Islands, from sources considered reliable. 2000 w. Nat Geog Mag—Dec., 1900. No. 38129 C.

**Smelting.**

Pyritic Smelting and Hot Blast. S. E. Bretherton. Considers questions relating to pyritic smelting, the ores suitable, etc. 2300 w. Eng & Min Jour—Dec. 29, 1900. No. 38452.

**Tailings.**

When to Begin Treatment of Cyanide Tailings. Henry M. Crowther. Suggests a profitable method of retreatment when conditions are favorable. 1500 w. Eng & Min Jour—Dec. 22, 1900. No. 38248.

**Tellurides.**

Notes on Tellurides from Colorado. Charles Palache. Describes a series of sylvanite crystals, in proof of the correctness of Pearce's conclusions published in 1894. Ill. 2700 w. Am Jour of Sci—Dec., 1900. No. 37960 D.

**Witwatersrand.**

Deep-Level Shafts on the Witwatersrand, with Remarks on a Method of Working the Greatest Number of Deep-Level Mines, with the Fewest Possible Shafts. Thomas Haight Leggett. Describes the gold deposits of this region and manner of working. 9600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38438 D.

## IRON AND STEEL.

**Address.**

Sir Lowthian Bell on the Progress of the Iron Industry. Address before the Institution of Junior Engineers. 5000 w. Ir & Coal Trds Rev—Dec. 7, 1900. No. 38203.

**Biwabik Mine.**

The Biwabik Ore Mine. An illustrated summary of work accomplished in opening this iron mine of the Mesaba range, by the stripping process. 1600 w. Ir Age—Dec. 13, 1900. No. 38135.

**Blast Furnace.**

The New Blast Furnace of the Marcinelle & Couillet Company (Le Nouveau Haut-Fourneau de la Société Anonyme de Marcinelle et Couillet). J. Smeysters. An account of two fine furnaces of 16.5 meters height and 160 metric tons capacity each, recently erected in Belgium, these being among the largest and finest on the Continent. 2000 w. Rev Univ des Mines—Nov., 1900. No. 38339 H.

**Cast Iron.**

The Chemistry and Physics of Cast Iron. Continued discussion of Mr. Kreuzpointner's paper entitled "Riddles Wrought in Iron and Steel." 4200 w. Jour Fr Inst—Dec., 1900. No. 38066 D.

The Influence of Silicon and Sulphur on the Condition of Carbon in Cast-Iron. Henry M. Howe. A study of this subject, giving the author's results, and examining the results of other investigations. 3800 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38433 D.

The Micro-Structure and Physical Properties of Cast-Iron, as Affected by Heat-Treatment, Especially in the Manufacture of Malleable Cast-Iron. A. T. Child and W. P. Heineken. Presents re-

sults of a series of experiments made in the metallurgical laboratory of Columbia University, New York City. Ill. 5200 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38436 D.

**Deposits.**

Peculiar Mines and Ore Deposits. Arthur Lakes. Illustrated description of the "contact deposits" of the La Plata Mountains, Colorado, and other deposits of interest. 2200 w. Mines & Min—Dec., 1900. No. 38033 C.

**Gold Deposits.**

Farncomb Hill Gold Deposits. Arthur Lakes. A description of the rich and peculiar deposits near Breckenridge, Colorado, and the methods of working them. 1400 w. Mines & Min—Dec., 1900. No. 38032 C.

**Hardening.**

Pack Hardening of Steel. E. R. Markham. Describes the method known as pack hardening and the necessary appliances. 1700 w. Loc Engng—Dec., 1900. No. 37967 C.

**Iron Mines.**

The Iron-Mines of Hartville, Wyoming. H. M. Chance. Gives the general characteristics, and detailed description of the openings. 7000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38432 D.

**Iron Ores.**

Notes on the Fossil Iron Ores of Georgia. S. W. McCallie. Describes the deposits, their chemical composition, and methods of mining. Ill. 1700 w. Eng & Min Jour—Dec. 29, 1900. No. 38451.

**Phase Theory.**

The Phase Theory of Iron and Steel (Le Fer et l'Acier au Point de Vue de la Doctrine des Phases). H. W. Bakhuis Roozeboom. A very complete discussion, translated, with comments, by Prof. Osmond. 20000 w. Bull de la Soc d'Encour—Nov. 30, 1900. No. 38321 G.

**Puddling.**

The Chemical Phenomena of Puddling. L. Cubillo. An account of experimental researches undertaken to ascertain whether the oxidation of the metalloids and metals which occurs in the cast-iron is caused by the oxygen of the oxidizing coating of the furnace, or by the oxygen of the gases which come from the hearth. Describes the entire operation. Ill. 3200 w. Ir & Coal Trds Rev—Nov. 30, 1900. No. 38118 A.

**Rails.**

The Kennedy-Morrison Rail Finishing Process. Brief illustrated description. 1700 w. Ir Age—Dec. 20, 1900. No. 38224.

**Separating.**

The Magnetic Separation of Iron Ores (Magnetische Aufbereitung der Eisenerze). H. Smits. Describing a number of machines and plants now in operation, being a paper read before the Mining Congress at Paris. 3000 w. Stahl und Eisen—Dec. 1, 1900. No. 38332 D.

The Magnetic Separation of Iron Ores. Hermann Wedding. On the machines used to separate the ores, and the attempts made to utilize the iron dust. 1200 w. Ir & Coal Trds Rev—Dec. 7, 1900. No. 38201 A.

**Slag.**

The Analysis of Slags and Cinders. C. H. Joüet. A paper intended as a guide for the analysis of the various slags and cinders from blast and reverberatory furnaces, producing pig and refined lead, copper and iron. 5800 w. Sch of Mines Quar—Nov., 1900. No. 38289 D.

**Steel Exports.**

The Pittsburg-St. Lawrence Route for Steel Exports. Waldon Fawcett. Discusses phases of the new steel transportation enterprise of the Carnegie Co. 1400 w. Eng & Min Jour—Dec. 22, 1900. No. 38246.

**Steel Plant.**

New Steel Castings Plant of the Shickle, Harrison & Howard Iron Company. Description, plan and interior views. 1500 w. R R Gaz—Dec. 7, 1900. No. 38097.

The Krieger Steel Works, Düsseldorf (Stahlwerk Krieger, Actiengesellschaft, Düsseldorf). A general description of an important works devoted to the production of steel castings. 2000 w. 1 plate. Stahl und Eisen—Dec. 1, 1900. No. 38331 D.

## MINING.

**Accidents.**

Accidents in the Saxon Coal Mines (Die Betriebsunfälle beim Sächischen. Steinkohlenbergbau). Dr. G. Stein. With data from 1888 to 1899, showing the diminution in the number of accidents. 2500 w. Glückauf—Nov. 24, 1900. No. 38342 B.

**Accounting.**

Principles and Methods of Profitably Working the Mine. A. G. Charleton. A discussion of office organization, cost-keeping, and records of work done, with numerous examples from actual successful practice. 6000 w. Engineering Magazine—Jan., 1901. No. 38381 B.

**Bore-Holes.**

Applications of Bore-Holes in Mining. Reviews some of the applications made of bore-holes. 2000 w. Eng & Min Jour—Dec. 15, 1900. No. 38173.

New Boring Methods (Ueber Einige Neue Bohrsysteme). W. Wolski. Especially discussing the Howarth system for deep boring, in which the impact boring tool is lowered into the hole. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 1, 1900. No. 38345 B.

**Electric Driving.**

Economy of the Application of Electricity in Collieries and Iron and Steel Works. Ernest D. Phillips. On the improvements in the apparatus used, some of the peculiarities of the modern machines and the advantages gained by their use. Ill. 2500 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38457 A.

Electrically-Driven Machinery in the "Adolf von Hausemann" Mine (Elektrisch Betriebene Maschinen auf der Zeche "Adolf von Hausemann"). R. Goetze. A very full description of this electric light and power plant in the Westphalia coal mining district. 3000 w. Glückauf—Dec. 8, 1900. No. 38343 B.

Electricity in Mines and Collieries. J. E. Hodgkin. Considers the extent to which electrical transmission may be adopted with profit in Great Britain. 4000 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38458 A.

Some Recent Developments of Electrical Power in Mines. Information concerning the most up-to-date German practice in electrical applications to coal mining. Ill. 4400 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38455 A.

**Electric Haulage.**

Electric Locomotives for Mine Haulage. An illustrated detailed description of an electrical locomotive for haulage purposes, with comparison of cost with mule haulage as shown by American practice. 2000 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38459 A.

Electric Haulage for Collieries. Ernest Kilburn Scott. Reviews the systems of haulage used in the collieries of Great Britain, considering points of importance in calculating the power needed. Ill. 3800 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38456 A.

**Explosion.**

Report on the Cwm Pit Explosion. Report of committee appointed to investigate the causes and circumstances of an explosion which occurred in Wales on May 14, 1900. 2000 w. Col Guard—Nov. 30, 1900. No. 38121 A.

**Explosives.**

Magazines for Mine Explosives. M. H. Le Chatelier. From a paper presented at the Paris Congress. Investigations of large underground depots, small underground depots, and surface depots, with conclusions from the safety standpoint. 2500 w. Col Guard—Nov. 23, 1900. No. 38002 A.

The Storage of Mining Explosives. On magazines and their advantages, considering facts enabling mine owners to decide if the consumption of explosives and available sites for magazines warrant the outlay. Ill. 3000 w. Col Guard—Nov. 30, 1900. No. 38120 A.

**Faults.**

The Great London Fault of the Mosquito Range and the London Mine. Arthur Lakes. An illustration of the evolution of a fault. 1600 w. Mines & Min—Dec., 1900. No. 38029 C.

**First Aid.**

The First-Aid Packet in Civil Practice and the Organization of First-Aid Societies. M. J. Shields. Calls attention to their value, especially in mining regions. 1300 w. Mines & Min—Dec., 1900. No. 38031 C.

**Hydraulic Mining.**

Notes on Hydraulic Mining. George H. Evans. Practical points necessary to be considered in carrying water in ditches, flumes, etc. Ill. 2200 w. Mines & Min—Dec., 1900. No. 38028 C.

**Management.**

The Practical Management of Mining Operations. John E. Hardman. A general review of the principles of successful practice in the management of mining operations. 5000 w. Engineering Magazine—Jan., 1901. No. 38380 B.

**Mine Cars.**

Welsh Mine Cars. J. Fox Tallis. Read before the So. Wales Inst. of Engs. An illustrated detailed description of some of the various types of cars in use in South Wales. 2000 w. Mines & Min—Dec., 1900. No. 38027 C.

**Mine-Surveying.**

The Evolution of Mine Surveying Instruments. Dunbar D. Scott. Continued discussion. Ill. 3800 w. Trans Am Inst of Min Engs—Dec., 1900. No. 38431 D.

**Mining Laws.**

Review of West Australian Mining Laws: A Comparison. George Hope. Written in the belief that helpful suggestions may be found to assist in the revision of American laws. 2100 w. Min & Sci Pr—Dec. 15, 1900. No. 38220.

**Mining Problems.**

Graphical Solution of Mining Problems. Leo Gluck. Describes methods and apparatus by which the labor of calculation can be materially reduced. Ill. 1600 w. Mines & Min—Dec., 1900. No. 38035 C.

**Philippines.**

Mining Machinery in the Philippines.

G. D. Rice. Illustrates and describes some of the native mining devices. 1000 w. Eng & Min Jour—Dec. 15, 1900. No. 38-172.

**Rock Drill.**

A New Electric Rock Drill (Ueber eine Neue Elektrische Gesteinsbohrmaschine). R. Classen. A revolving diamond drill is driven from an electric motor by means of a flexible shaft. 2000 w. Glückauf—Nov. 24, 1900. No. 38341 B.

**Safety Lamps.**

Experiments on the Best Dimensions of Safety Lamp Covers (Versuche zur Ermittelung der Zweckmässigsten Abmessungen der Sicherheitslampenkörbe). H. Fändrich. Giving the results of investigations into the best proportions for the wire-gauze covers for lamps of the Davy type. 3000 w. 2 plates. Glückauf—Dec. 1, 1900. No. 38344 B.

**Shafts.**

Deep Shaft Sinking. J. L. C. Rae. Relates the circumstances and events which had a bearing on the work, and describes the shaft-sinking of Sydney Harbor Colliery. 4200 w. Aust Min Stand—Nov. 8, 1900. Serial. 1st part. No. 38406 B.

**Wire Ropes.**

Statistics of Hoisting Ropes (Statistik der Schachtförderseile). Giving data as to the life of iron and steel wire ropes in mine hoisting from data collected in Germany since 1872. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 8, 1900. No. 38346 B.

### MISCELLANY.

**Analysis.**

The Sulphocyanides of Copper and Silver in Gravimetric Analysis. R. G. Van Name. Describes experimental investigations. 2400 w. Am Jour of Sci—Dec., 1900. No. 37961 D.

**Diamonds.**

Diamonds and the Diamond Industry. W. R. Matthews. Facts concerning the diamond industry in South Africa and New South Wales, showing the many inducements to an exploitation of the latter areas. 2500 w. Aust Min Stand—Oct. 25, 1900. No. 38055 B.

**Limburgite.**

An Occurrence of Limburgite in the Cripple Creek District. E. A. Stevens. An illustrated description of this occurrence, with the writer's views. 1300 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38434 D.

**Metallurgical Plant.**

See Electrical Engineering, Power Applications.

**Oil Fields.**

Oil and Gas Yielding Formations of California. W. L. Watts. Information from a bulletin, soon to be issued by the Mining Bureau, concerning the extent and value of these fields, their geological formation, etc. 1300 w. Min & Sci Pr—Nov. 24, 1900. Serial. 1st part. No. 37957.

The Kern River Oil-Field in California. An account of this newly-developed and productive territory. 1000 w. Eng & Min Jour—Dec. 8, 1900. No. 38095.

**Quartz Reefs.**

The Downward Extension of Quartz Reefs. A. W. Howitt. Read before the Victoria Chamber of Mines. A statement of the writer's opinions based on extensive study, with arguments supporting them. Ill. 3300 w. Aust Min Stand—Oct. 25, 1900. No. 38054 B.

## RAILWAY AFFAIRS

### CONDUCTING TRANSPORTATION.

**Accidents.**

The Accident to the Sud Express. Charles Rous-Marten. Explains the requirements of this train, and discusses the probabilities that might furnish an explanation of the accident, giving the writer's opinion that it was due to a "wash-out." 3500 w. Engr, Lond—Nov. 23, 1900. No. 37997 A.

**Discipline.**

Record Discipline. Reviews the paper read by Charles Dyer before the Rocky Mountain Ry. Club, and the discussion, with editorial comment. 2800 w. R R Gaz—Dec. 21, 1900. No. 38252.

**Employees.**

The Discipline and Control of Railway Employees. W. H. Canniff. A review of the methods which have been found most successful in American railway management. 3500 w. Engineering Magazine—Jan., 1901. No. 38387 B.

**Relief.**

Railroad Employees' Relief. J. A. Anderson. An account of the origin and formation of the Relief Department of the Pennsylvania Railroad, and the results of 14 years' operation. 3000 w. R R Gaz—Dec. 21, 1900. Serial. 1st part. No. 38-254.

## FINANCIAL.

**Valuation.**

Expert Valuation of Railway and Other Corporate Property in Michigan. Concerning the accurate valuation undertaken under the direction of the Michigan Board of State Tax Commissioners. Explains the purpose and scope of the work, and the organization of the force, etc. 9300 w. Eng News—Dec. 20, 1900. No. 38231.

## MOTIVE POWER AND EQUIPMENT.

**Air Brakes.**

Air Brake Hose Specifications. An account of foreign practice presented by J. Doyen at the International Ry. Congress. 1100 w. Am Engr & R R Jour—Dec., 1900. No. 38044 C.

Report of Committee on Air Brake Efficiency. Followed by discussion by members. 10700 w. Cent Ry Club—Nov., 1900. No. 38210 C.

**Caboose.**

The American Caboose Car. An illustrated detailed description of the latest standard forms of caboose cars and their construction. 5000 w. R R Car Jour—Dec., 1900. No. 38125.

**Car Lighting.**

Electric Passenger-Coach Lighting. Emerson L. Clark. Illustrates and describes the axle-driven system, claiming its advantages over the one generating unit system. 1600 w. W Elect'n—Dec. 22, 1900. No. 38250.

**Coal Cars.**

Coal Cars of 80,000 Pounds' Capacity. Illustrated description of cars for the Chicago, Burlington & Quincy Railroad. 600 w. Am Engr & R R Jour—Dec., 1900. No. 38042 C.

New 100,000-lb. Hopper Bottom Coal Cars—Norfolk & Western Railway. Drawings and information concerning new cars soon to be built. 500 w. R R Gaz—Nov. 30, 1900. No. 37973.

**Coupling.**

An Improved Coupling Appliance for Railway Wagons. Illustrated description of a recent invention by Edward Hill, of London. A most ingenious arrangement. 1600 w. Col Guard—Dec. 14, 1900. No. 38402 A.

**Electric Locomotives.**

See Electrical Engineering, Power Applications.

**Fireboxes.**

A Study in Locomotive Fireboxes. F. F. Gaines. A discussion of remedies for the prevention of staybolt failures in the firebox of a locomotive boiler, suggesting a possibility of discontinuing their use. Ill 1800 w. Am Engr & R R Jour—Dec., 1900. No. 38043 C.

The Depth of Wide Fireboxes. Editorial giving the opinions of various correspondents, with comments. 1000 w. Am Engr & R R Jour—Dec., 1900. No. 38045 C.

**Locomotives.**

A General Examination of the Locomotives Exhibited at Paris (Allgemeine Betrachtungen über die in Paris Ausgestellten Locomotiven). Rolf Sanzin. A comparative study of the various engines, with respect to their national characteristics, having reference to the various loading gauges of different countries. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 7, 1900. No. 38314 B.

Are Six-Coupled Locomotives Necessary for Trains That Run 100 Miles or More Between Stops? General discussion by members. 9000 w. N. Y. R R Club—Nov. 15, 1900. No. 38157.

Express Compound Locomotive for the Karsei Railway, Japan. Illustrated description, with dimensions. 600 w. Engng—Dec. 21, 1900. No. 38462 A.

Chicago & Eastern Illinois Twelve-Wheeler. Illustrated description of a very heavy compound engine. 450 w. Loc Engng—Dec., 1900. No. 37970 C.

Locomotives of the Madison Incline. An illustrated account of the building of the "Madison Incline" in the State of Indiana, and a study of the engines which have been used on this line. 3000 w. Ry Age—Dec. 7, 1900. No. 38124.

Observations Upon the Locomotives at the Exposition of 1900 (Quelques Observations Relatives aux Locomotives à l'Exposition de 1900). The first installment of a general review of the exhibited locomotives as illustrative of the development of the subject. Serial, Part I. 2500 w. Revue Technique—Dec. 10, 1900. No. 38330 D.

Saddle Tank Locomotive. Illustration, with brief description, of a locomotive recently built for a railway in South Wales. 250 w. Engr, Lond—Nov. 23, 1900. No. 37998 A.

Smith & Perkins' Last Type of Locomotives. C. H. Caruthers. Illustrated description. 1000 w. Loc Engng—Dec., 1900. No. 37968 C.

Some Foreign Four-Cylinder Compound Locomotives. Illustrations of five engines, discussing some superficial features. 1500 w. R R Gaz—Dec. 7, 1900. No. 38098.

Tandem Compound Express Locomotive by the Poutiloff Works, St. Petersburg (Locomotive à Grande Vitesse "Compound Tandem" Construite par l'Usine Poutiloff à St. Petersburg). F. Barbier. Full detailed description of 56-ton Russian engine, exhibited at Paris. 2500 w. Génie Civil—Dec. 8, 1900. No. 38327 D.

The Erie's Six-Wheel Switching Loco-

motives—Wide Fire-Box. Illustrated description. 600 w. R R Gaz—Dec. 21, 1900. No. 38253.

The First Locomotive in the Holy Land. William Crawford, Jr. Brief illustrated account of the first engine run over the road from Joppa to Jerusalem. 1000 w. Loc Engng—Dec., 1900. No. 37966 C.

The Paris Exhibition—Société Suisse, Winterthur. Illustrated descriptions of four railway locomotives and a tramway locomotive, exhibited by this firm. 1500 w. Engr, Lond—Nov. 30, 1900. No. 38115 A.

The Relative Advantages of Ordinary and Compound Locomotives. Charles Ernest Wolff. Considers compound locomotives in general, and also various types, their advantages and disadvantages, and gives conclusions reached. 4200 w. Prac Engr—Nov. 30, 1900. No. 38107 A.

The Thuile High-Speed Locomotive (Locomotive à Grande Vitesse, Système Thuile). F. Barbier. Illustrated description of the peculiar and powerful locomotive exhibited by the Creusot works at the Paris Exposition. 2000 w. 1 plate. Génie Civil—Nov. 17, 1900. No. 38300 D.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway (Locomotive Mixte Compound à Trois Cylindres des Chemins de Fer Jura Simplon). F. Barbier. Description of the engines built at Winterthur for the special Alpine service of the Jura-Simplon road, and exhibited at Paris. 1500 w. Génie Civil—Dec. 1, 1900. No. 38306 D.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway. Illustrations and description of one of sixty locomotives constructed for this railway which was exhibited at Paris. 800 w. Engng—Nov. 30, 1900. No. 38113 A.

Two-Cylinder Compound Consolidation Locomotive. Illustration and brief description of engines for the "Soo" Line. 250 w. Am Engr & R R Jour—Dec., 1900. No. 38046 C.

**Railway Wagons.**

Capacity of Railway Wagons as Affecting Cost of Transport. J. D. Twinberrow. Read before the Inst. of Mech. Engs. Indicates the course of railway finance during the last decade, and discusses the economies possible, especially by employing vehicles of greater earning capacity. Ill. 3800 w. Engng—Nov. 23, 1900. Serial. 1st part. No. 37996 A.

**Staybolts.**

Another Improvement in Staybolts. An illustrated detailed description of an important improvement devised by J. B. Barnes. 1500 w. Am Engr & R R Jour—Dec., 1900. No. 38041 C.

**Trucks.**

Engine Truck of the Western Railroad of France. Illustrations and description of an interesting engine truck, with shifting center, designed for fast express locomotives. 500 w. R R Gaz—Dec. 14, 1900. No. 38167.

## NEW PROJECTS.

**New Line.**

Great Lakes & Hudson Bay Railway. An account of the line under construction, starting at Sault Ste. Marie, and expected to require three years to complete. 500 w. U. S. Cons Repts, No. 902—Dec. 4, 1900. No. 38018 D.

## PERMANENT WAY AND FIXTURES.

**Culvert.**

Concrete Arch Culvert, L. E. & D. R. Ry. Plans, illustrations and specifications for a culvert of 20 ft. space, recently constructed. 700 w. Ry & Engng Rev—Dec. 15, 1900. No. 38198.

**Port Arthur.**

The Manchurian Southern Railway and the Russian Harbor of Port Arthur (Die Süd-Mandschurische Eisenbahn und der Russische Kriegshafen Port Arthur). F. Theiss. With map and views of the harbor, showing its military advantages. 1800 w. Glaser's Annalen—Nov. 15, 1900. No. 38337 D.

**Roadbed.**

Practical Necessity of a Thoroughly Good Roadbed for the Fast and Economical Handling of Traffic. Michael L. Lynch. Considers the importance of location of railways, remodeling, improvements of roadbed, track, etc. General discussion. 2 plates. 2500 w. St. Louis Ry Club—Nov. 9, 1900. No. 37958

**Shops.**

The New Shops of the Colorado & Southern. Ground plan, illustrations and description. 2000 w. Ry Age—Dec. 14, 1900. No. 38184.

**Signals.**

Automatic Train Signals (Selbstthätige Zugdeckung). A. Birk. An examination of the increasing demands for automatic block signals, in view of the reduced headway of trains, together with suggestions for improvements. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 23, 1900. No. 38311 B.

Signaling for the Pan-American Exhibition. Gives plan of the Buffalo Belt Line of the N. Y. C. R. R., and brief account of the signaling equipment. 400 w. R R Gaz—Dec. 7, 1900. No. 38099.

**Station.**

The Nashville Union Station. Illustrations and general plan of yards, with description. 2800 w. Ry & Engng Rev—Dec. 22, 1900. No. 38417.

**Ties.**

The Preservation of Railway Ties in Europe. Discussion of paper by Octave Chanute. 6200 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38443 E.

**Train-Shed.**

The Peoria Train-Shed. Illustrated description of a 477 x 109-ft. train-shed, with some unusual structural features and special methods of roof illumination. 700 w. Eng Rec—Dec. 8, 1900. No. 38084.

**TRAFFIC.**

**Freight.**

The Bessemer Heavy Traffic Freight Route. Gives a profile of the Pittsburg, Bessemer & Lake Erie, also speed diagram, with an account of the method of operation and the economical effect. 2800 w. R R Gaz—Dec. 21, 1900. No. 38255.

**Rules.**

Car Interchange Rules in Europe. A summary of the regulations of the principal countries. 900 w. R R Gaz—Dec. 7, 1900. No. 38100.

# STREET AND ELECTRIC TRAMWAYS

**Accumulators.**

Traction by Accumulators (La Traction par Accumulateurs). A discussion of the report of MM. Broca and Johannet at the International Tramway Congress at Paris. 3000 w. Electricien—Dec. 15, 1900. No. 38357 B.

**Barcelona.**

Electric Tramways in Barcelona and Vicinity. Gives particulars regarding progress on roads under construction, and changes made from horse and steam to electric traction, etc. 700 w. U. S. Cons Repts, No. 909—Dec. 13, 1900. No. 38145 D.

**British Guiana.**

Electric Railway for Georgetown, Demerara. N. Swan and Norman S. Rankin. An account of a modern electric railway in British Guiana, in a city of over 60,000 inhabitants. Ill. 3000 w. St Ry Rev—Dec. 15, 1900. No. 38234 C.

**Cable.**

Edinburgh Cable Tramways. A statement of the present condition of affairs. The new cable lines amount to 37 miles of track, covering some 10 miles of street. 2000 w. Ry & Tram Wld—Dec. 6, 1900. No. 38274 A.

**Cars.**

Double-Truck Cars. N. H. Heft. Read at the Kansas City convention of the Am. St. Ry. Assn. How to construct and equip them to obtain maximum efficiency with minimum cost of maintenance. 1500 w. St Ry Jour—Dec. 1, 1900. No. 37986 D.

**Congress.**

The International Tramway Congress (Congrés International des Tramways). Charles Jean. An abstract of the questions and discussions at the congress held in connection with the Paris Exposition of 1900. 2500 w. Génie Civil—Nov. 17, 1900. No. 38302 D.

**Construction Work.**

Difficult Construction Work on the Lines of the Third Avenue Railroad Company, New York. Brief illustrated description of work at the post-office loop. 450 w. Elec Rev, N. Y.—Dec. 12, 1900. No. 38162.

**Contact Rails.**

Contact Rails on Manhattan Elevated. Illustrated description of rails being installed in New York, in preparation for electrical operation. 300 w. St Ry Rev—Dec. 15, 1900. No. 38235 C.

**Deri System.**

The Deri System of Electric Traction (Trazione Elettrica Sistema Deri). G. Oliva. Two motors are used on each car; one alternating motor receiving current from overhead wire, and one continuous current motor fed from an accumulator carried on the car. 1800 w. Elettricta—Dec. 1, 1900. No. 38350 B.

**Distribution Systems.**

A System of Current Distribution for Tramways (Du Système de Distribution du Courant à Adopter pour les Grandes Réseaux de Tramways). P. Van Vloten. Paper and discussion at the International Tramway Congress at Paris. Two articles, 7000 w. Electricien—Nov. 24, Dec. 1, 1900. No. 38355 each B.

Systems of Current Distribution. M. Van Vloten. Read at Paris Congress. Discusses the best method for the distribution of current for large systems of tramways, including suburban lines, susceptible of extension to long distances. 5700 w. Tram & Ry Wld—Oct. 11, 1900. No. 38137 A.

**Electric Locomotives.**

See Electrical Engineering, Power Applications.

**Electricity vs. Steam.**

Electrical Locomotives and Multiple-Driven Axles. Edward H. Tyler. Con-

cerning the circumstances that must determine which is the better system. 2200 w. Engng—Dec. 21, 1900. No. 38463 A.

Electric Traction on Railways (La Trazione Elettrica nelle Ferrovie). D. Civita. A general discussion as to the practicability of the introduction of electric traction on main line railways. Three articles, 6000 w. Elettricita—Nov. 17, 24, Dec. 8, 1900. No. 38348 each B.

On the Supersession of the Steam by the Electric Locomotive. W. Langdon. Read before the Inst. of Elec. Engrs. Considers the question to be mainly a matter of economy. 3000 w. Elec Engr, Lond—Nov. 30, 1900. Serial. 1st part. No. 38105 A.

The Electrical Working of Main Line Railways. Ernest Kilburn Scott. A discussion of paper by W. Langdon, on "The Supersession of the Steam by the Electric Locomotive," read before the Inst. of Elec. Engs., England. 1600 w. Elec Rev, Lond—Dec. 7, 1900. No. 38216 A.

Main Line Electric Traction. An account of the opening of an electric road between Albany and Hudson, in New York State. 1400 w. Elec Rev, N. Y.—Nov. 28, 1900. No. 37965.

The Albany & Hudson Third Rail Road. Illustrates and describes a long third-rail line recently opened. 2000 w. Elec Wld & Engr—Dec. 8, 1900. No. 38127.

**Electrolysis.**

Electric Traction Troubles. Discusses the troubles arising from electrolysis since the introduction of electric traction in England. 1400 w. Nature—Nov. 22, 1900. No. 38003 A.

**French Tramways.**

The Construction of Tramways in France. H. Conradi. A comparison between the different methods of traction based on the first cost, deducting from this what are the economical conditions under which one or other system is most suitable. 2700 w. Ry & Tram Wld—Dec. 6, 1900. No. 38273 A.

**Gradient Railway.**

The Halford Gradient Railway. Brief illustrated description of a novel suspension railway utilizing the laws of gravity. 1200 w. Sci Am—Dec. 29, 1900. No. 38281.

**Hudson River Line.**

The New Jersey & Hudson River Railway & Ferry Co. An illustrated description of the Fort Lee ferry, and the line to Englewood and Hackensack, N. J. 1800 w. St Ry Rev—Dec. 15, 1900. No. 38233 C.

**Leeds.**

Leeds Tramway Plant. Illustrated description of the horizontal cross compound engines used in this English plant. 1800 w. Engr, Lond—Dec. 14, 1900. No. 38266 A.

**Moving Sidewalk.**

Operating Data of the Moving Sidewalk and Electric Railway at the Paris Exposition. Diagrams showing power supplied to the electric railroad and to the moving platform, with comments. 900 w. Elec Wld & Engr—Dec. 15, 1900. No. 38182.

**N. Y. Elevated**

Electric Traction Equipment of the Manhattan Elevated—New York City. Discusses the changes to be made, and their advantages. Also editorial. 2700 w. R R Gaz—Nov. 30, 1900. No. 37974.

Electric Traction on the New York Elevated Railways. An account of the first trips of electric motor trains over the Manhattan Railway Co.'s elevated structure in Second avenue, New York City, with editorial. Ill. 2000 w. Elec Rev, N. Y.—Nov. 28, 1900. No. 37964.

**Norwich, Eng.**

Norwich Electric Tramways. Illustrated detailed description. 3300 w. Tram & Ry Wld—Dec. 6, 1900. No. 38270 A.

**Permanent Way.**

Permanent Way for Electric Traction. H. Ross Hooper. Shows the importance of permanent way to the success of electric traction, discussing materials and construction. 3000 w. Ry & Tram Wld—Dec. 6, 1900. No. 38271 A.

**Philippines.**

The Trolley in the Philippines. Discusses its outlook as a field for electric railway promoters. 2500 w. St Ry Rev—Dec. 15, 1900. No. 38237 C.

**Polyphase.**

Polyphase Electric Traction. C. A. Carus-Wilson. Discusses some features of the polyphase system, particularly those relating to punctuality and frequency of train service. Ill. 2400 w. Elec Engr, Lond—Dec. 7, 1900. Serial, 1st part. No. 38214 A.

**Repair Shops.**

The Repair Shops of the Brooklyn Rapid Transit Company. Illustrated description of shops, showing the most complete modern methods of systematically handling street-railway repairs. 2200 w. St Ry Jour—Dec. 1, 1900. No. 37983 D.

**Sicily.**

Electric Railway Possibilities in Sicily. Cesare Pio. An account of the schemes for electric traction developing in this island, where no tramways have ever been laid. 1300 w. St Ry Jour—Dec. 1, 1900. No. 37985 D.

**Storage Batteries.**

Storage Batteries in Railway Power

Stations. H. H. Morris. Read before the N. Y. State Ry. Assn. Considers the uses and advantages, and describes the Buffalo plant and the tests made, discussing the results. 4500 w. St Ry Rev—Dec. 15, 1900. No. 38238 C.

**Subways.**

Rapid Transit Subways in Metropolitan Cities. Illustrated account of the subways of London, Paris, Budapest, Glasgow and Boston. 5000 w. Munic Affairs—Sept., 1900. No. 38290 C.

**Suspended Railway.**

The Barmen-Vohwinkel Suspended Railway. Illustrates and describes details of this railway as given in a series of articles in the *Centralblatt der Bauverwaltuez.* 1400 w. Elec Engr, Lond—Dec. 14, 1900. No. 38405 A.

**Underground Railway.**

The Metropolitan Underground Railway of Paris, France. An illustrated description of the contemplated system and of the work already done, prepared from a paper by Raymond Godfernaux; in the *Revue Generale des Chemins de Fer.* 3700 w. Eng News—Dec. 6, 1900. No. 38082.

The Underground Electric Railways of London. Gives the main points in the prospectus of the Baker Street & Waterloo Railway Co. and a general view of what is being done in the way of underground electric railways. Map. 3000 w. Ry & Tram Wld—Dec. 6, 1900. No. 38272 A.

**Wannsee.**

Electric Traction on the Wannsee Railway (Elektrische Zugförderung auf der Wannseebahn). H. Bork. A paper read before the Railway Society at Berlin, giving full details of the construction and operation, with discussion. 6000 w. Glaser's Annalen—Dec. 1, 1900. No. 38325 D.

# NEW BOOKS

COMPOUND ENGINES. By F. R. Low. New York: Power Publishing Co. A series of elementary papers upon the theory of compound engines, well adapted for the instruction of the engine driver and operator.

MACHINES MARINS. By L. E. Bertin. Paris: E. Bernard & Cie. The portion of the course in steam engineering of the Ecole du Génie Maritime relating to marine engines, forming undoubtedly the most complete and recent treatise upon the subject in the French language. The work forms a worthy companion to M. Bertin's treatise on marine boilers, the two books covering the subject of marine motive power very fully, especially as representing the present state of the art in France.

LES BATEAUX SOUS-MARINS. Vol. I. Historique. Vol. II. Technologie. By MM. F. Forest and H. Noalhat. Paris: Vve. Ch. Dunod. Undoubtedly the most exhaustive treatise upon the absorbing subject of submarine navigation which has yet appeared in any language. The experiments of all the leading investigators are given, and the details of the latest constructions upon which engineers are now working in Europe and America, with numerous illustrations.

DIE PRAKTISCHEN BEZIEHUNGEN DER KINEMATIC ZU GEOMETRIE UND MECHANIK. By Prof. Dr. F. Reuleaux. Braunschweig: Frederich Vieweg und Sohn. London: Williams & Norgate. This important volume forms the second and concluding portion of Professor Reuleaux's great work, of which the first, the "Theoretical Kinematics," was given to the world more than twenty-five years ago. In this book are given the methods of applying to practical work the ingenious notation of the earlier volume, enabling a problem to be analyzed and the practical solution determined according to the theoretical methods of the distinguished author.

THE RECLAMATION OF LAND FROM TIDAL WATERS. By Alexander Beazeley, M. Inst. C. E. London: Crosby, Lockwood & Co. A handbook for engineers, landed proprietors and other interested in the reclamation of land, including the construction of the bank, the method of drainage, and the best methods of cultivating the reclaimed area, together with an examination of the legal questions involved.

TECHNISCHE MECHANIK. Ein Lehrbuch der Statik und Dynamik. By Ed. Autenreith. Berlin: Julius Springer. A thoroughly modern treatment of the principles of theoretical mechanics, with especial reference to the applications of modern technology in the domain of the civil and mechanical engineer.

MOULDER'S TEXT-BOOK. By Thomas D. West. New York: John Wiley & Sons. London: Chapman & Hall, Limited. This work forms Part II. of "American Foundry Practice," and is devoted to a discussion of methods for obtaining good castings, and problems in difficult moulding, together with an examination of the subject of cupola construction, and the melting of iron and scrap steel in iron foundries.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA. By Charles Proteus Steinmetz, with the assistance of Ernst J. Berg. Third edition, revised and enlarged. New York: *Electrical World and Engineer,* Incorporated. A new and revised edition of Mr. Steinmetz's very full treatise of the phenomena of alternating electric currents, in which graphical and algebraic methods are freely used, the vector analysis being introduced, and the symbolic representation of general alternating waves.

FIELD FORTIFICATIONS. By G. J. Fieberger. New York: John Wiley & Sons. London: Chapman & Hall, Limited. The text book used in the course of instruction at the United States Military Academy at West Point, with examples taken from field operations in the Russo-Turkish War of 1878, and of the Franco-Prussian War of 1870.

KRAFTMASCHINEN DES KLEINGEWERBES. By J. O. Knoke. Berlin: Julius Springer. An exhaustive reviews of small motors, including hydraulic motors, hot-air engines, and the various forms of internal combustion motors. Gas engines are discussed at length, as are also the different forms of benzine and petroleum motors, both for stationary and automobile service, and a chapter is given to small steam engines.

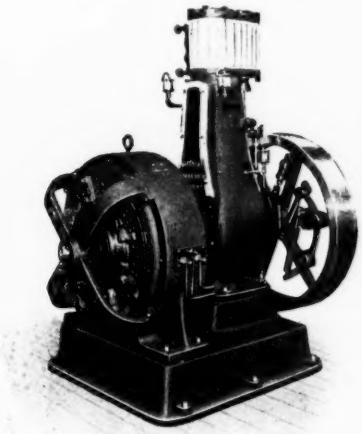
# IMPROVED MACHINERY

**New Processes and New Appliances**

*The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.*

### A Direct-Connected Generating Set.

ECONOMY of steam consumption is, of course, a most vital consideration in the performance of an engine, for upon that depends the coal bill. It often happens, in addition, that installation conditions demand economy of floor space. The accompanying illustration shows a type of engine fulfilling both these requirements in the highest degree. It is a standard upright engine manufactured by the Buffalo Forge Company, of Buffalo, N. Y., and in this case is connected to a generator of the Triumph Electric Company's make, though it will be understood, of course, that any standard dynamo may be so connected. The rigid cast iron frame of the upright enclosed type has one cylinder-head cast a part thereof, and to this is bolted the cylinder and steam chest, though in the smaller sizes the cylinder also is cast on a frame. Cylinder and guides are bored with the same setting of the boring bar, so that perfect alignment must result.



A unique feature of this upright engine is that it is enclosed to run in oil, so that perfect lubrication of the main bearings, crank pin, wrist pin and guides is assured. Other bearing surfaces are cared for by continuous oilers of large capacity, and for the cylinder and steam chest a large sight-feed lubricator is provided. As a result of this thorough system, smooth running at continuous high speeds is readily possible. Another feature which renders this engine valuable for high speed lighting and power service is close regulation. This is afforded by a centrifugal fly-wheel governor of great sensitiveness. The latter property follows in part from the careful design, which provides three means of adjustment for the governor, and in part, also, from the provision of ample lubrication for all the governor pins and rubbing surfaces of the valve motion. The valve, it may be added, is of the piston type, perfectly balanced.

In view of the illustration shown, it is hardly necessary to comment upon the extremely small floor space required for such a generating set. This feature has resulted in its extensive application to marine service, where the requirements are especially severe. The machine in question has a range of sizes from 4 to 100 horse-power.

### Crane Company at Paris.

ONE of the exhibits at the Paris Exposition which attracted wide attention was that of Crane Co., the largest manufacturers of valves and fittings in the world, the head offices and factories of which are located in Chicago. This exhibit occupied a desirable position in the Palace of Machinery and Electricity, Champs de Mars, and consisted of brass and iron valves and cocks for all pressures, brass and iron fittings, steam specialties, engineers' supplies, and steam and gas fitters' tools.

Crane Co. was the only exhibitor of this

class of goods to receive a gold medal. The exhibit was tastefully arranged, as will be seen from the accompanying photograph, and gave an especially good opportunity to visitors to study approved modern methods of piping, flanged work, etc., for power plants—a branch of the business of this company which has become very important.

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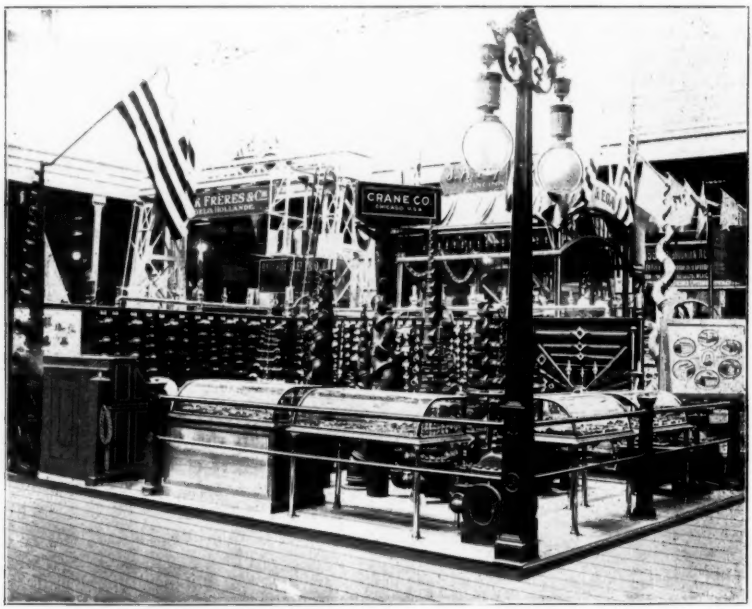
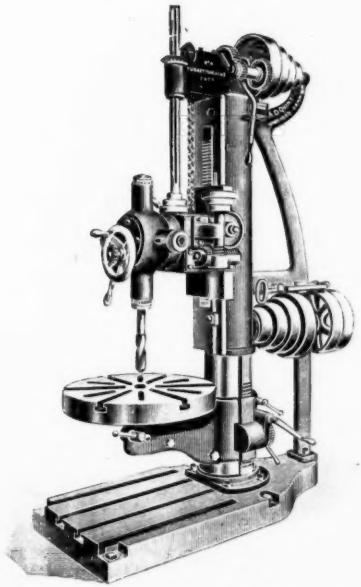
### New Vertical Turret Machine.

We illustrate herewith a vertical turret machine with revolving spindles, made by A. D. Quint, Hartford, Conn., and in operation at the Lincoln Company's shop, Hartford. This machine is designed for boring, drilling and tapping, and is made with sliding head, power and hand feed, automatic stop, and quick return. The machine is distinguished from other turret machines from the fact that the cutting tools revolve instead of the work, thus not restricting the work operated on to a size that will revolve on a table. The machine will finish a hole at one setting of the work, thus assuring accuracy with rapidity of operation, regardless of size or irregularity of piece operated on.




The base, column, stand and table are of the well known type of upright drills. The sliding head on the column is balanced by weight, and carries the feed mechanism, the locking index, and the gearing for transmission of motion from vertical shaft to the revolving tool spindle. On the sliding head is mounted a four-spindle turret, free to revolve on the head. All spindles in the turret are indexed to the same point when the spindle is in position for working. In use the spindle only revolves. Any spindle wanted may be swung to position, without stopping machine, by means of the lever seen on the front of the turret, which, when moved 45 degrees to the right, will release the index bolt. When the turret is revolved to the spindle wanted, the lever will automatically lock the turret with the spindle running in position for work.

The hand-feed is operated by means of a hand wheel in front of the turret. The power feed, with three changes, is operated by belt and cone pulleys on the sliding head, being started and stopped by the knob in front of the hand wheel. The power feed is also stopped automatically with the stop



shown in the slot in the face of the column, which may be adjusted for any depth of hole up to 28 inches. The quick return of the head is effected by means of a pilot wheel on the left-hand side of the sliding head, which operates a pinion in mesh with the rack in the face of the column.

The clutch for connecting and disconnecting the back gears may be thrown in or out, while the machine is running, by means of the lever shown at the side of the column. All handles, etc., for operating the machine, are placed in a convenient position for the operator. The machine is so constructed that any tapping device on the market may be used.

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### Leschen Aerial Tramway.

THE accompanying cut illustrates the style of bucket and the automatic clip lock used on Leschen's aerial wire-rope tramway. The tramway is of the double rope type, having two stationary cables upon which the buckets travel, and an endless traction cable, by which the buckets are propelled and controlled. These ropes are supported upon derricks or towers, which are placed usually about 200 feet apart, but spans of longer length are made where the condition of the route demands it. The clips are button shaped and are fastened to the rope by means of two drop forged bands which encircle the rope. These bands have the lay of the rope forged in them, making it an impossibility for them to slip, no matter how great the load, or steep the grade. The shape of the dip allows it to run over or under the sheave, as desired.

Between the bucket pendants is attached the automatic clip lock, consisting of a housing in which two trip dogs are fastened. These trips are connected to a sliding frame, which when raised drops the trips back. When the clip attaches itself to the bucket, the slide is raised by engaging with an inclined plane. This drops the trip and the clip enters the lock. The slide then drops and forces the trip back, thus locking the clip to the bucket. The clip disengages from the buckets in like manner; the slide, when raised, drops the trip and the clip passes

out of the housing. After the bucket has been detached from the clip its speed is gradually diminished by means of a lever until it stops at the desired point. In like manner before the bucket is attached to the clip it receives an acceleration to overcome its inertia.

The buckets are discharged by coming in contact with a wrought iron frame, which when raised gradually upsets the bucket. This dumping arrangement is indirectly connected with the terminal wheel shaft, and works automatically.

The operation of the whole tramway is automatic, the buckets being attached and detached to and from the traction cable, and discharged without any manual labor. A single attendant can operate the whole line of tramway.

The principal features obtained in Leschen's tramway are the low cost of maintenance, automatic movements, perfect safety, and its adaptability for transporting material in any section of the country, whether mountainous or level.

Manufactured by the A. Leschen & Sons' Rope Co., of St. Louis, Mo.

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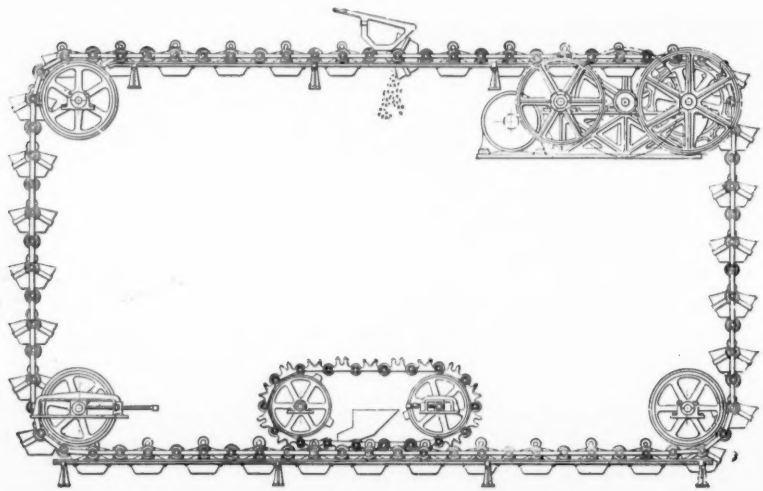
### Exeter Gravity Conveyors.

THE illustration herewith shows the mechanical design of the Exeter gravity conveyors, the system being installed by the Exeter Machine Works for the New York Gas, Electric Light, Heat & Power Co., at their Seventy-ninth street station.

The chain is constructed of drop forged steel links with eyes reinforced and enlarged, giving maximum strength and wearing surface. A heavy steel bushing or sleeve passes through the links and a steel pin through the sleeve. The wheels rest upon the sleeves and are self-lubricating, the wearing and friction being reduced to a minimum. The buckets are made of pressed steel and are extra heavy. The dumping arrangement is perfectly smooth in its operation, the bucket discharging its load in the opposite direction to the movement of the conveyor. The loader is another noticeable feature of this conveyor, being simple in its operation and perfectly accomplishing the purpose for which it is intended. It consists of an endless chain carrying V caps; the spaces correspond to the spaces between the buckets and fitting closely over the edges of the buckets an absolutely endless trough is formed at the loading point. The loader is made either stationary or portable, or, if there are several loading points to be used simultaneously, the loader can be made of sufficient length to reach these different points.

The conveyor is driven by sprocket wheels



engaging with the wheels of the chain. All sprockets are made of steel castings, and steel banded traction wheels are employed at all angles.

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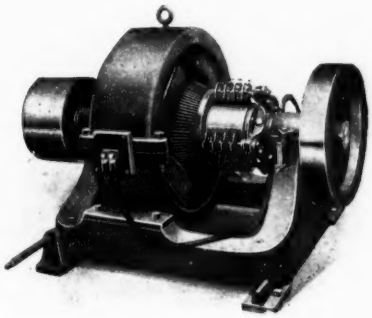
### Bernard Dynamos and Motors.

In the Bernard line of multipolar slow speed dynamos and motors the aim has not been to introduce radical and questionable changes, but to build high-grade machines embodying only such points as are known to give the best electrical and mechanical results. Moreover, no detail was adopted until long test absolutely assured its decided advantage over every other. No "experiments" are ever incorporated in the commercial apparatus. These aims and eighteen years of experience have combined to make a machine which is not excelled for durability, workmanship, efficiency, small heat losses, regulation, sparklessness, artistic design, and involving in operation a minimum amount of attendance.



A descriptive bulletin and further details may be had from the E. G. Bernard Co., Troy, N. Y.

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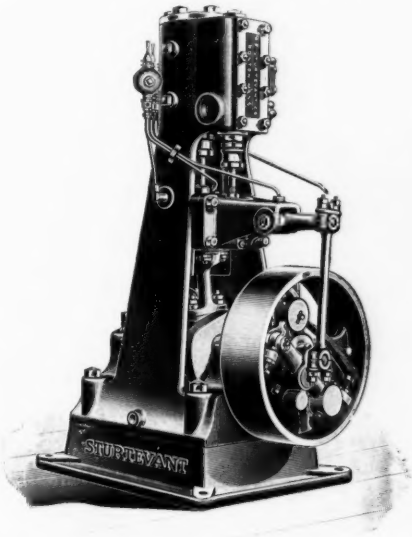
### Small Vertical Engine.

The accompanying illustration presents a type of small vertical engine adapted to general use, recently brought out by the B. F. Sturtevant Co., Boston, Mass. It is built in three sizes, ranging from 2 to 4 horse-power, with speeds from 1,000 revolutions for the smallest size down to 650 revolutions for the largest.

It is in aspect a perfect miniature engine, complete in every detail, and designed with the utmost care. The frame is rigid in



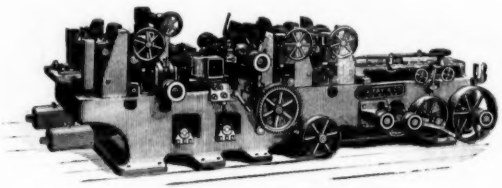

its design, spreads well at the base and resists vibration, notwithstanding the fact that the weights have been kept down to the minimum, ranging from 160 pounds for the smallest up to 450 for the largest engine. The steam is distributed by means of a piston valve actuated by the automatic governor, which is complete in all its features. The effect of the reciprocating parts is overcome by suitable counterbalance of the crank plates. The connecting rod is of the marine type. All moving parts are adjustable for wear, and a complete oiling system is provided for the individual bearings. The cylinder is lagged to reduce the condensation, and access to the piston valve and steam chest is provided by means of a removable cover.

This line of engines was primarily designed by the Sturtevant Co. for use with their generators in torpedo boat service, where the minimum weight was absolutely essential. The same type of engine is built to be operated by throttling governor and is also very generally employed for fan driving, being then directly connected to the fan

shaft. The cylinder is tapped for indicator and is also provided with the necessary drip valve connections. The small diameter of the cylinder and the extra thickness of the walls make it possible to run at a pressure of 150 pounds, and even higher, although the powers above specified are those developed at 80 pounds initial pressure.

**Double Cylinder Flooring Machine.**

We illustrate a new double cylinder flooring machine just brought out and placed on the market by J. A. Fay & Egan Co., Cincinnati, Ohio.



This new machine, which will plane four sides 9 to 14 inches wide and 6 inches thick, has embodied in its construction many new devices and conveniences not heretofore contained in a machine of this description. Among the more noticeable of its mechanical advantages are:

The pressure bar before the first upper cylinder is adjustable both to and from the cut, and the bar after the cut is adjustable for difference in thickness of material; also the bars before and after the second upper cylinder.

The pressure bars both before and after the lower cylinder are adjustable vertically and laterally.

A pressure bar, with independent adjustment, extends over the matching works, and can be thrown out of the way quickly.

The patent weighted matcher-clip, which produces a uniform pressure on the material.

The feed, consisting of six rolls 8 inches in diameter, driven by a train of powerful gearing extending through the machine, and the expansion gears on feed rolls are inside the frame.

The manufacturers will furnish prices and full particulars of this or any other wood-working machinery to any who may be interested.

# NEW CATALOGUES AND TRADE PUBLICATIONS

*These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.*

Power Specialty Co., New York.—A handsome catalogue illustrating and describing the Williamson non-automatic acetylene generator, and the Beck & Zander automatic generators. Much interesting information about the generation, properties, and uses of acetylene gas are given.

Chattanooga Machinery Co., Chattanooga, Tenn.—A pamphlet describing, in satisfactory detail, the Catlin key-seating machine. An interesting feature of this machine is that a cutting tool can be removed and another inserted in the cutter bar in about one second.

American Steel & Wire Co., Chicago.—Small catalogue of Crown rail bonds, illustrated and described in a variety of shapes to meet all conditions of rail bonding.

Geo. E. Dow Pumping Engine Co., San Francisco, Cal.—Very complete catalogue presenting a line of steam, electric, and power pumps, and general hydraulic machinery. Section details and carefully prepared tables aid to a clear understanding of the various patterns illustrated, and their especial adaptabilities and efficiencies.

Burnham, Williams & Co., Philadelphia, Pa.—Handsome catalogue in colors, de-

scribing, with, photograph and lucid text, the Atlantic type of locomotive of the Baldwin Locomotive Works. The tables of performance and sizes are very instructive.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Tasteful brochure in English, French, and German, illustrating in detail pneumatic hammers and chippers. The numerous photographs showing the tools at work under all sorts of conditions are especially interesting.

THE DEMING CO., Salem, Ohio.—A bound catalogue of convenient size for consultation, showing a very complete line of hand and power pumps and accessories. Much valuable hydraulic data is to be found in this catalogue.

FOREST CITY PAINT & VARNISH CO., Cleveland, O.—Small catalogue of paints and varnishes, with interesting information about the proper use of paint.

LANDIS TOOL CO., Waynesboro, Pa.—An exceptionally practical catalogue on the construction and use of universal and plain grinding machines for cylindrical, conical and plane face surface work. Detail drawings are numerous, and many illustrations show the operation of grinding machines and their adaptability to a variety of work.

NORTON EMERY WHEEL CO., Worcester, Mass.—Folder illustrating emery and corundum wheels and machinery. An interesting machine, the Walker universal tool and cutter grinder, is shown. This grinder is especially adapted to tool room use.

THE BALL ENGINE CO., Erie, Pa.—Catalogue "M" of belted and direct connected self-oiling engines from entirely new designs and patterns. Many interesting tables are given, showing dimensions and power ratings at different speeds and pressure of self-oiling high-speed engines, simple, tandem compound, and cross compound.

WILLIAM HARRIS & SON, Pittsburg, Pa.—Small catalogue about mine car hitchings.

DODGE MANUFACTURING CO., Mishawaka, Ind.—Small brochure neatly illustrating the Dodge American system of rope transmission for horizontal and vertical driving, main engine driving and drives involving distance, angles or reverse motion. The photographs are very interesting, and show the wide range of application of the rope drive.

COLUMBIAN FIRE-PROOFING CO., Pittsburg, Pa.—An attractive descriptive catalogue of the Columbian system of fire-proof floors, consisting of ribbed steel bars suspended in stirrups over steel beams, and embedded in concrete. Numerous interior and exterior views are shown of buildings in which this system is employed.

NEW ERA IRON WORKS, Dayton, Ohio.—Well printed and illustrated catalogue of gas and gasoline engines, especially in large sizes. Many interesting features are embodied in this engine, and the views of working parts are instructive.

UNION STEAM PUMP CO., Battle Creek, Mich.—Convenient reference catalogue of the Moore and Burnham patterns of steam pumps for varied duties. A section of the catalogue on modern steam pump practice gives much interesting and valuable data.

G. A. CROSBY & CO., Chicago.—Folder describing an electrically-operated shop for the manufacture of metal stamping machinery.

FOX MACHINE CO., Grand Rapids, Mich.—Abridged catalogue No. 19, describing in brief multiple spindle drills, milling machines, crank and belt shapers, planer vises, pipe and tube cutters. Many very clear illustrations are given.

KEARNEY & TRECKER, Milwaukee, Wis. Pamphlet describing in considerable detail the "Milwaukee" milling machine, a rugged and compact machine, designed to meet the varied and exacting requirements of the modern tool room.

PERKINS MACHINE CO., Boston, Mass.—Illustrated catalogue and price list of power presses and tools. This line of machines is from new patterns and designs, and many valuable features are shown.

MORRIS MACHINE WORKS, Baldwinsville, N. Y.—Neat and handy catalogue of centrifugal pumping machinery and stationary and marine engines. The many illustrations are well made and clearly printed, and, together with the text, give just the information needed by the buyer.

CONTINENTAL IRON WORKS, Borough of Brooklyn, New York.—Bound catalogue of the Morrison suspension corrugated furnace, showing many details and formulæ valuable to the steam engineer.

MANNING, MAXWELL & MOORE, New York.—A bound catalogue of over 700 pages, quarto, illustrating a complete line of metal and wood-working machine tools.

HANSON & VAN WINKLE CO., Newark, N. J.—A booklet about compress polishing wheels, telling how they are made, what they will do, and how they do it.

CINCINNATI SHAPER CO., Cincinnati, Ohio.—Descriptive folder of a twenty-four inch back geared crank shaping machine, giving two illustrations and tables of dimensions.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa.—One of the very handsome catalogues of this house, in four languages, and illustrating many applications of Westinghouse motors to stationary service.

AUGUST MIETZ, New York.—Detail catalogue of the Mietz & Weiss engine operated by gas or kerosene, illustrating its applications, etc.

YAWMAN & ERBE MFG. CO., Rochester, N. Y.—Card illustrating and describing in brief a line of labor-saving office furniture and devices.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Catalogue No. 1030, neatly illustrating and describing in satisfactory detail an extensive line of electric mine locomotives and pointing out their exact adaptation to the requirements of mine haulage. Many views of electric locomotives at work add interest to the book.

JEFFREY MANUFACTURING CO., Columbus, Ohio.—Catalogue No. 57 of elevating and conveying machinery, covering the sawmill, lumber, and wood-working industries. Many of the views are of actual installations, and the details of the apparatus are treated at length.

FOX MACHINE CO., Grand Rapids, Mich.—An attractive catalogue of a line of four styles and ten sizes of universal wood trimmers for trimming pieces of wood smoothly and accurately on any angle.

ARTHUR KOPPEL, New York.—Catalogue in large quarto, describing in six languages an extensive line of permanent and portable railways. This book is virtually an album of views in many countries where the Koppel system has been installed, and the entire work is highly interesting.

SPRAGUE ELECTRIC CO., New York.—Bulletin No. 204, illustrating in detail the Lundell octagon type motor for automobiles. The sizes range from two to fifteen horse-power.

SCRANTON STEAM PUMP CO., Scranton, Pa.—A neat little catalogue of a new and novel steam pump known as the "Straightway."

BILLINGS & SPENCER CO., Hartford, Conn.—A folder illustrating the Kelsey noiseless ratchet brake, in which the teeth are raised clear of each other when the handle is turned in a backward direction, thus preventing noise and wear on the teeth.

LANE & BODLEY CO., Cincinnati, O.—A pamphlet entitled "A Modern Corliss Engine," containing a paper read before the last convention of Cotton-Seed Oil Mill Superintendents, at San Antonio, Tex., by J. C. Weaver.

CLEVELAND PNEUMATIC TOOL CO., Cleveland, O.—An art brochure illustrating a line of pneumatic hammers, drills, and pneumatic appliances. Sectional views of the tools are given, and many views show the wide possibilities of pneumatic appliances.

H. W. JOHNS MFG. CO., New York.—A booklet about asbestos fire-felt pipe and boiler covering, and containing many interesting views of the three-days' fire at the works of the Standard Oil Co., Bayonne, N. J., last summer. It is notable that the asbestos coverings survived the disaster fully as well as, and in many cases better than, any other part of the equipment.

RISDON IRON & LOCOMOTIVE WORKS, San Francisco, Cal.—Catalogue No. 1 of an extensive line of engines and boilers, feed-water heaters, and boiler-feed pumps.

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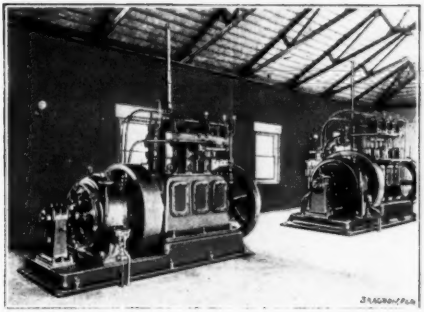

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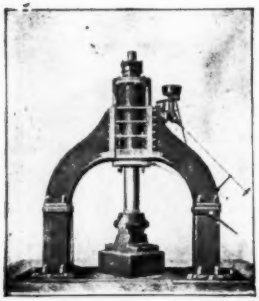

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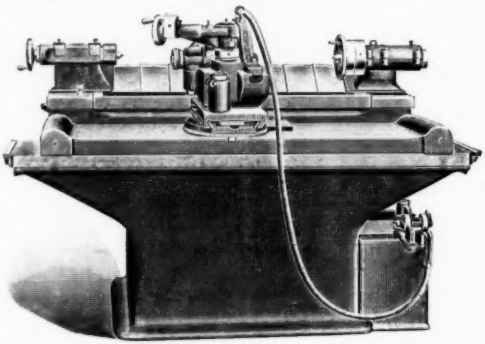

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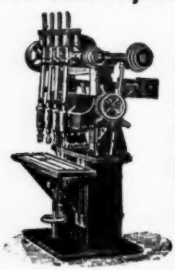

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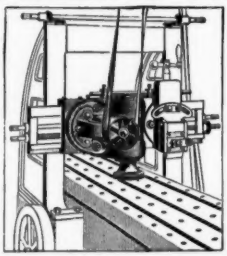
## MILLING MACHINE



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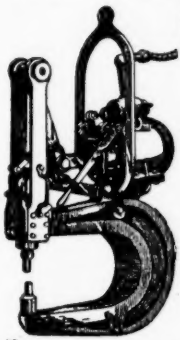

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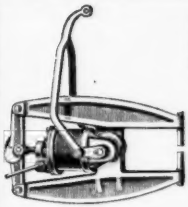

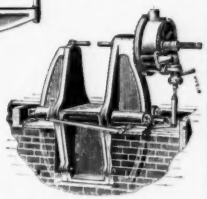

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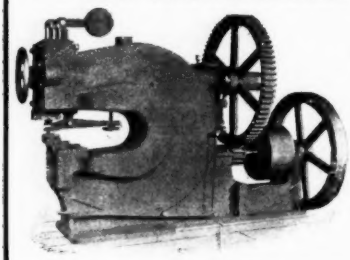

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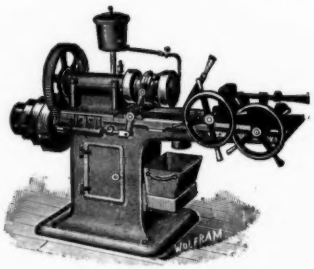


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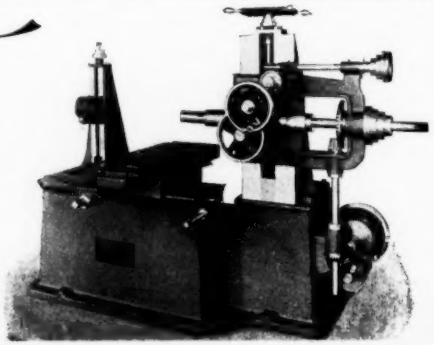

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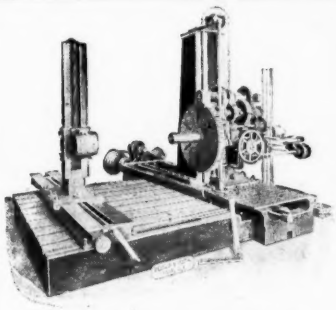

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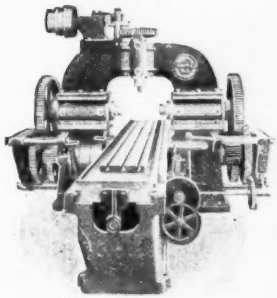

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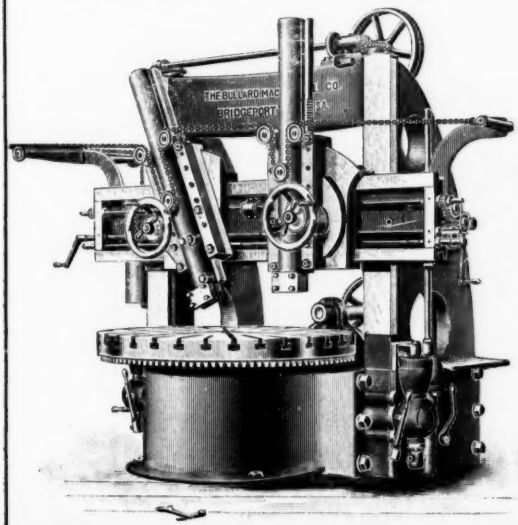


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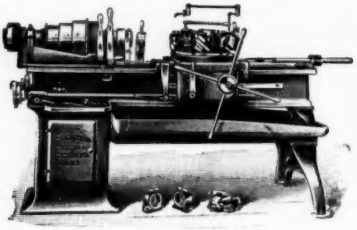

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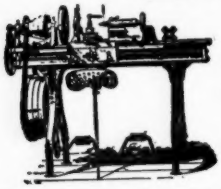

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